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A Monthly Review of Veterinary Science.

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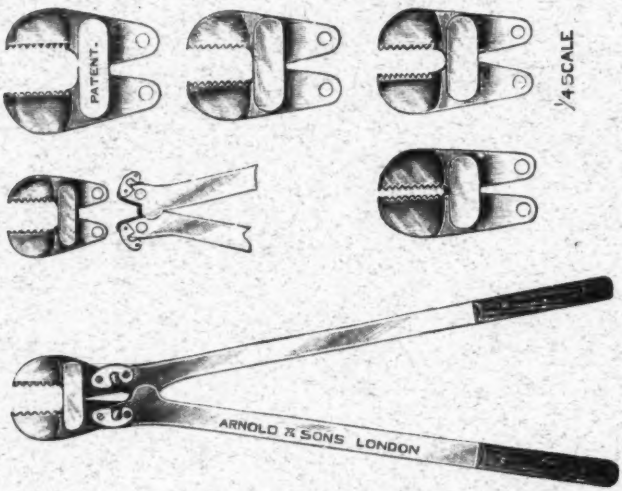

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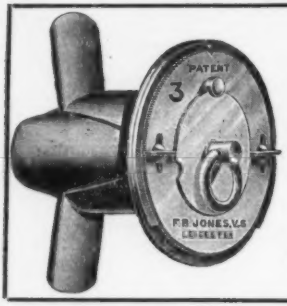

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JOHN G. RUTHERFORD, C.M.G., Hon. Assoc. R.C.V.S.

THE

VETERINARY JOURNAL

JUNE, 1912.

JOHN G. RUTHERFORD, C.M.G., HON. ASSOC. R.C.V.S.

No man, whether veterinarian or layman, has gained more respect and popularity amongst the members of our profession in Canada, and indeed amongst all agriculturists, than Dr. J. G. Rutherford, the late Veterinary Director-General and Live Stock Commissioner of that portion of our Empire.

His resignation, after ten years' service, has caused general regret, and from every side appreciation of the good work which he has done for the Department and for agriculture in general has been showered upon him.

What he has done since his appointment in 1902 is something to be proud of. He has constructed a Government Veterinary Department where none previously existed, one which sends forth veterinarians properly trained to carry on the administrative work, to enforce the provisions of the law where necessary, to inspect meat intended for human food, and to grapple with the hundred-and-one problems associated with the diseases of stock; whilst skilled veterinary pathologists and bacteriologists deal with these branches of the work in a well-equipped laboratory.

As the result Dr. Rutherford can look back with pride upon the almost complete eradication of glanders, rabies, hog cholera, and several other diseases, whilst mange and sheep-scab are fast disappearing; and the task of eradicating any contagious disease is by no means an easy one in a country whose frontiers are not surrounded by water and in which the districts are vast and sparsely populated.

His election to the Presidentship of the American Veterinary Medical Association was a direct proof of the esteem in which he was held by his American and Canadian *confrères*; and, at the recent banquet after the meeting in Toronto it was by unanimous accord that Dr. Rutherford was appointed Toastmaster (the

position of honour at all American and Canadian convivial gatherings), the duties of which can only be properly fulfilled by a man of genial temperament. He has served his country as a Member of the Canadian Legislature, and three years ago was made a C.M.G. He is an Honorary Associate of the Royal College of Veterinary Surgeons, and has many friends in England who hope to welcome him on this side of the Atlantic at the forthcoming Meeting of the International Veterinary Congress in 1914, if not before.

Editorial.

THE SAFE DOSAGE OF ARSENICAL AND COPPER PREPARATIONS.

We whole-heartedly commend to the careful perusal of our readers the excellent article in this issue which we have extracted from Dr. Theiler's report of his experiments on sheep with white arsenic, Cooper's Dip (an arsenical preparation), and copper sulphate; both alone and in combination.

Dr. Theiler's object was to determine, if possible, the maximum doses of these agents that can be given to a number of sheep with safety. Obviously with such substances a considerable number of experiments was advisable, and this investigator is fortunate in being placed in such circumstances as to enable him to carry out his most useful work on the subject. The drugs in question are constantly used internally in the treatment of parasitic affections of sheep, affections which are responsible for incalculable loss to sheep farmers in all quarters of the globe. Numerous vermicidal agents have been recommended and tried, but the success has not been very gratifying. It may be that we have erred on the side of too small doses, for fear of killing the hosts as well as the parasites.

We may at once say that the most prominent feature revealed by Dr. Theiler's exhaustive experiments is that one can give to sheep with safety, doses of arsenic and copper considerably in excess of what has hitherto been regarded as safe doses. He has shown that for adult sheep, powdered white arsenic is safe in gr. xxx doses, while of bluestone gr. xx (which might be slightly increased), and of Cooper's Dip gr. xv are safe doses.

As one might have expected, when any two of these irritant and corrosive substances were combined, the doses had to be reduced, so that if white arsenic and bluestone were combined only gr. xv of each could be given with safety, and the same dosage applied to a combination of Cooper's Dip and bluestone. While these doses proved safe with adult sheep, lambs proved susceptible to considerably smaller doses; in fact, gr. viiss each of Cooper's Dip and bluestone proved fatal to six out of thirteen lambs between 3 and 6 months old. Unfortunately no further lambs were available to determine a safe dosage and the investigator promises to return to the question later.

As we have already stated, it was to be expected that combinations of potent drugs would increase their activity and necessitate the reduction of doses, but one was hardly prepared for the revelation that those safe doses would be rendered dangerous by the admixture with such comparatively harmless substances as common salt and sulphur. Yet such is apparently the case, so much so that the mixture of Cooper's Dip and bluestone, safe in gr. xv doses of each for adults, was unsafe in gr. xi doses of each if combined with the same amounts of salt and sulphur. Hence, if one wishes to give those maximum doses with safety they must not be mixed with other drugs even though apparently harmless.

In order to avoid the danger of "drenching pneumonia," Theiler's experiments were carried out with powdered drugs, and therein probably lies the explanation of safe use of such large doses of white arsenic. With whatever arsenical agent he was experimenting, toxic doses were always more serious in their effects if the animals were watered immediately after dosing than if kept without water for twenty-four hours. White arsenic is only slowly soluble unless combined with some acid or alkali, and its power of penetration depends upon its solubility. Hence, if given in the form of a powder, its effects would be expected to be less penetrating, and so less toxic, than if given in solution or with an agent which increases the solubility such as potash or soda salts.

As is usual with Dr. Theiler's work, this contribution to our knowledge is so thorough and replete with useful information that it is impossible for us to more than touch the fringe of it, so we recommend a study of our extract or of the original report.

General Articles.

NODULAR DISEASE OF THE INTESTINES OF CATTLE.*

By WALTER JOWETT, F.R.C.V.S., D.V.H.
Capetown.

NODULAR disease of the intestine of the sheep ("knopziekte," as it is popularly termed), is quite well known to those interested in sheep and sheep-farming in South Africa, but, as far as one can judge by perusal of the literature relating to the diseases of animals in this country, little attention appears to have been paid, so far, to an almost identical nodular disease of the intestine of cattle, which is met with quite frequently, at any rate in Capetown and the neighbouring districts in the Cape Province. There is no doubt that the "knopziekte" of sheep is widely spread throughout South Africa, being met with, in all probability, wherever sheep-farming is carried on at all extensively; whether the closely related nodular disease of the intestine of the bovine animal is equally prevalent, one is not yet in a position to state with any considerable degree of certainty; as already mentioned, it is common enough in the Cape Peninsula, and it is hoped that by calling attention to the subject one may as a result gain some idea as to the prevalence of the disease elsewhere in the Union. With this object, then, and for the benefit of those interested in the subject, a short account of this peculiar diseased condition of cattle is here given, together with some notes and observations from cases met with by the author. From one very well marked case recently encountered I was fortunately enabled to prepare specimens for minute (microscopical) examination.

NATURE OF THE NODULAR INTESTINAL DISEASE.

The disease now under consideration is characterized by the formation of many small lumps or tubercles in the tissue immediately underlying the lining membrane of the intestine of animals affected. These nodules are usually round, firm, pea or "shot-like," and usually vary in size from that of a pin's head to that of a pea; occasionally somewhat larger tubercles or nodules are encountered,

* From the *South African Agricultural Journal.*

but the majority usually lie within the limits mentioned. They may be scanty in numbers, but not uncommonly hundreds of such nodules are present, in which event, of course, their presence can hardly fail to be noted. They are often apparent even before the intestines are opened, showing through the outer (serous) coat sometimes quite distinctly; they are, however, much more in evidence when the gut has been split open, cleaned, and its lining membrane is submitted to direct observation. When this is done a number of small lumps or projections are seen in the wall of the gut, the lining membrane of the latter being usually continued in an uninterrupted layer over their surface, for all the world as if a number of small or large peas had been placed within the substance of the tissue forming the wall of the intestine. Sometimes in the older nodules—occasionally in the case of fairly recent ones—the lining membrane of the gut is broken, ulcerated, or, more usually, considerably thickened at the site of the nodules; ulceration, however, is not a very common complication of this disease in the case of cattle.

The commonest site of the nodules is in the sub-mucous tissue of the small intestine, but they are encountered also quite frequently in the large gut, occupying here, likewise, a similar site beneath the mucous membrane, between the latter and the muscular coat, and encroaching more or less on one or other or both of these layers.

The size of the nodules has already been mentioned. With respect to colour, they vary in accordance with their age; the smaller and younger nodules are generally black (hæmorrhagic), the medium-sized ones are either uniformly black or else they are white and black, whilst the larger and older nodules are either uniformly white, yellowish, or they may have greenish-yellow contents. Still older nodules are generally hard and fibrous, sometimes one finds them composed of firm fibrous walls enclosing contents which may be caseous, or in part or wholly calcareous.

Cause of the Disease.

Each of the recently formed or comparatively recently formed nodules encloses *one* minute larval nematode ("worm") surrounded by cells which have accumulated in response to, and as a part of, the inflammatory process excited by its presence.

In size the young nematode in the nodule measures only from about 2 to 3 mm. (roughly $\frac{1}{12}$-in.) in length. It is, therefore, not

an easy matter to detect its presence unless one's vision is aided by the microscope.

Old nodules, as already remarked, frequently contain a yellowish or greenish-yellow material, surrounded by fibrous walls; in such nodules the demonstration of the parasite, if still present, is rather more difficult. In still older nodules with dry, firm, fibrous consistency, it is usually impossible to demonstrate the parasite, for the best of all reasons, it is no longer present therein, having migrated to the lumen of the intestine, there to become mature and to complete its life's cycle.

Life Cycle of the Causal Parasite.

The worm as met with in the sub-mucous nodule of the intestine is still in the larval condition; here it undergoes ecdysis, and in time becomes an immature adult, when the cyst (nodule) *usually* ruptures (occasionally this does not happen, in which event the parasite ultimately degenerates, and in the end may be impregnated with lime salts).

Obviously, when the nodule or cyst ruptures, the contained immature worm escapes into the lumen of the gut. Whilst it remains in the nodule, the parasite shows no sexual differentiation, but after it has been liberated from the cyst or nodule and has passed into the contents of the intestinal tube, it there undergoes further developmental changes, growing and developing finally into either a male or a female adult worm. After this the two sexes copulate in the lumen of the gut of their host.

The fertilized female worm gives origin to a number of eggs; these in the case of a closely related parasite (œsophagostome) of man and the monkey already show segmentation whilst still in the uterus of the worm—a similar condition likewise probably holds good in the case of the parasite of cattle now under consideration. In due course the eggs pass to the exterior with the host's fæces, and there undergo certain further developmental changes, the length of time occupied in this process depending, no doubt, upon the suitability or otherwise of the surrounding temperature, conditions of humidity, &c. It is likely, however, that a supply of oxygen, as contained in the atmosphere, is essential at this stage of development.

In time, each egg gives rise to a young embryo "worm." The embryo ultimately gains access to the intestine of a new host (ox

with soil, food, or water. It then burrows into the lining membrane of the gut, or, according to some authors, reaches the ultimate site it occupies in the sub-mucous tissue by means of the blood-stream. Be that as it may, the embryo is finally arrested in the sub-mucous coat of the intestine, where it gives rise to the formation of a hæmorrhagic cyst—the nodule so characteristic of the disease.

Identity of the Parasite.

The nodular disease of the intestines of bovines was first described by Drechsler, of Munich, in 1876. Saake afterwards confirmed the findings of Drechsler. Ostertag states that he has frequently seen the sub-mucous nodules in the intestines of cattle slaughtered at the Berlin abattoir.

As to the identity of the larva, the causal agent of this diseased condition, there has been much diversity of opinion, it being, of course, impossible to determine the species of a given parasite of this nature by the mere examination of larval specimens alone, and, as already pointed out, it is only such immature worms which are present in the sub-mucous nodules. The determination of the species, then, rests on the result of examination of adult and sexually mature worms—the males especially—which are present in the *intestinal contents* of the host; these, however, are not invariably present in the lumen of the gut of the ox concurrently with the presence of the larva containing nodules in its intestinal wall. Moreover, it is somewhat difficult at times to isolate worms so minute as are those now under consideration from the large mass of material contained in the bovine intestine. The adult parasite occurring in the intestinal contents, even when fully developed, measures only 15 to 20 mm. in length (roughly about $\frac{3}{4}$ to $\frac{4}{5}$ in.), whilst the larval worm in the nodule is only $\frac{1}{12}$ in. long. Strose, and some of the earlier writers who studied this condition, regarded the small nematode present in the nodules as an ankylostome (*A. bovis*), von Ratz being one of the first to consider it as representing the larval stage of a different species of parasite, namely an œsophagostome. More recently Marotel has studied the question of the identity of the parasite afresh in France, and, as a result of his researches, he has definitely shown that the nematode present in the nodules is, in reality, a larval œsophagostomum. This investigator finds that the particular species concerned in the case of cattle in France is the *Œsophagostomum radiatum*. According to

Marotel, the young nematode passes through at least three successive stages :—

(1) A strongyliform larva with a small mouth; (2) an ankylostomiform larva with an ellipsoid and monodentated mouth; and (3) an œsophagostomiform larva with an elliptical and cuticular enlargement in the cervico-ventral region.

Says Marotel in this connection: "Each nodule encloses a young œsophagostome of variable shape and development. The length of the worm does not exceed 3 mm. in the case of the ox (this measurement, of course, refers only to the worm found in the nodule). As long as they measure less than 4 or 5 mm. these larvæ correspond to three types; those of 1 mm. resemble strongyles (strongyliform larvæ); those of 2 mm. remind one of ankylostomes (ankylostomiform larvæ); those of 3 mm. are comparable to œsophagostomes (œsophagostomiform larvæ). Finally, the individuals which exceed 4 or 5 mm. are perfect, but still immature œsophagostomes; in order to reach the adult state, to copulate, and to reproduce, they are obliged to quit the nodules and to gain the lumen of the intestine."

The evolution of the œsophagostome, then, comprises two parts, the one which is effected in the interior of the intestinal nodules, and the other which is passed in a free state in the intestinal cavity; the first is of variable length, in accordance with the species nvolved.

Here one may state that the larva found in the intestinal nodules of the South African cattle is, as far as one can judge, identical with the parasite depicted by Marotel as present in similar nodules in the intestinal walls of cattle in France, and, as far as this investigation is concerned, the present writer regards the parasite responsible for the diseased condition here dealt with as an œsophagostome. Whether the species involved in South Africa is *O. inflatum* or *O. radiatum* one is not yet prepared to affirm, more extended study of adult specimens being necessary to decide this point. However, so far, the author inclines to the view that it may be the species last referred to (*O. radiatum*), but one hopes to study this question further as the opportunity to do so presents itself.

Symptoms.

With regard to the symptoms exhibited by cattle, the subjects of the nodular intestinal disease, much depends upon (1) whether the

infection is a heavy one or otherwise; (2) whether it is recent or of some standing; and (3) the degree of resistance which the host is able to offer against the harmful effect of the parasitic invasion. Says Marotel in this connection: "Clinically it (*i.e.*, the nodular intestinal disease) reveals itself by the appearance of a chronic enteritis, watery diarrhœa, progressive wasting, anæmia, and cachexia; it terminates usually in three or four months by death in coma, and its gravity is such that in certain cases the mortality reaches the startling figure of 50 per cent." From this description it is apparent that the disease, at any rate as met with in France, is of considerable economic importance. The present writer, however, is inclined to think that the nodular disease of the intestines of bovines encountered at the Cape is somewhat less grave than the picture drawn by the French investigator above quoted. It is not unusual, when conducting *post-mortem* examinations on cattle slaughtered for food purposes, or on those which have succumbed to some rapidly fatal disease other than the one here dealt with, to find nodules quite numerously present along the course of the intestinal tract, and yet such animals may be in quite good condition, and they may have shown no very obvious symptoms of illness prior to death. On the other hand, there can be little doubt but that where the parasitic invasion is a heavy one, or when it occurs in an animal not in very robust condition, diarrhœa and symptoms of chronic intestinal irritation will be apparent, attended ultimately with more or less anæmia and wasting, and occasionally, perhaps, by death. Such termination, however, is probably not of very frequent occurrence, at any rate, in the case of cattle at the Cape.

Obviously, a heavy invasion by the parasite referred to cannot do otherwise than impair the health of the host to a more or less appreciable extent, and to interfere with its nutrition and well-being. It seems justifiable to ascribe some of the diarrhœas of cattle, often seemingly of obscure origin, to this cause. Moreover, it is well recognized that the lesions excited by the parasite may form the starting points of other diseases; the nodules may, in fact, form the portals of entry for various micro-organisms normally occurring in the intestinal tube, and which, though harmless under ordinary conditions—that is *so long as they remain in this position* (in the *contents only* of the intestine)—become decidedly pathogenic (disease producing) once they have gained access to the general circulation, and

they are of course especially liable to do so when a wound or abrasion exists in the lining membrane of the gut—herein lies one obvious danger to the host from the presence of certain species of "worms" in its intestine.

Differential Diagnosis.

The only disease with which it is at all possible that the above described lesions may be confounded is tuberculosis of the intestine, and this mistake is hardly likely to be made by anyone who is in the least acquainted with the lesions of the malady last mentioned. However, examination ot the mesenteric lymphatic glands ("kernels") will speedily settle any doubt which may exist, for whilst these are invariably involved in intestinal tuberculosis, they are intact in the case of the nodular intestinal disease (œsophagostomiasis), provided, of course, that the latter is not complicated by some other disease involving the mesenteric lymph glands.

It may not be out of place to call attention to certain lesions of the mesenteric glands, and sometimes also of the liver, which are not uncommonly met with in cattle at the Cape, namely, those due to invasion by the larval form of the *Linguatula tænoides* (this larval form being known as the *L. denticulata*).

The adult (the *L. tænoides*) is a parasite of the nasal cavities of the dog. The eggs are deposited on grass or water, and in this way they ultimately find their way to the intestinal system of some herbivorous animal—ox or sheep, &c. Once having gained the intestinal tract of one or other of these animals, the embryos migrate to certain of the visceral structures, often, apparently, to the mesenteric glands. Here they give rise to the formation of nodules, which, in certain respects, are not unlike those caused by the tubercle bacillus, at any rate to ordinary naked-eye examination, and especially so, of course, if the examination be but a casual one or is made by an untrained observer. These "linguatula nodules" vary in size from a pin's head to a pea, or may be even much larger than this, and after a time they assume a greenish or yellowish-grey to a green colour, and are frequently of a caseous, mortar-like, or even calcareous consistency. The colour is somewhat characteristic, but in case of doubt microscopic examination will decide the question ; the parasite, or if this has degenerated, then its hooks, will be found in the nodules, whilst of course in the case of tuberculous lesions the specific bacillus can be demon-

strated. The writer has found the "pentastome lesions" of the mesenteric glands co-existent in some cases with the parasitic nodular disease of the intestine in cattle at the Cape—a combination of lesions which might deceive the layman, and especially so if only a casual or hasty examination had been made.

Concluding Remarks.

Preventive Measures, &c.

With regard to prevention and treatment of the nodular disease of the intestine one has but few remarks to offer. It is obvious that whilst the larvæ remain encysted in the wall of the intestine—that is in the nodules—drugs administered to the host by the mouth will hardly be likely to come in contact with or to have much effect on them.

In the case of valuable animals, one can treat the symptoms of diarrhœa and irritation of the intestine as they arise by the administration of astringents and demulcents—chalk, catechu, and opium in gruel, for example. Raw eggs may be added to this mixture with benefit.

The administration of medicinal agents, such as arsenic, tartrate of antimony, or thymol, will probably rid the host of some of the round worms free in its intestinal contents. Afterwards tonics, such as iron salts (sulphate), and a liberal allowance of rock or common salt, are indicated.

With regard to prevention, naturally, if one is aware that animals become infected at a certain pasturage or with one particular water supply, one should remove them, if possible, from such source of infection.

The intestinal contents of slaughtered cattle in which lesions of the nodular disease are present in the intestinal walls should be disposed of in such manner (burning, burying, &c.) that they do not contaminate fresh pasture, since such material is liable to contain adult and fertilized female worms as well as the ova of these.

There is no reason against the use of the meat of such carcases for food purposes, provided that it is not emaciated, and that it is otherwise free from evidence of disease.

THE HUMAN TRYPANOSOME OF NORTHERN RHODESIA.

By "RHODESIAN."

In the *Rhodesia Herald* of April 19, 1912, is published an article on the Liverpool School of Tropical Medicine, in which the following paragraph occurs:—

"Dr. Stephens kindly volunteered any information or assistance that might be desired. It was difficult to realize that this unassuming gentleman, working here in Liverpool, had just discovered a new sleeping sickness trypanosome. It was still more difficult to realize what this discovery might not mean to South Africa, where the *Glossina morsitans*, now held capable of conveying sleeping sickness, is not only very prevalent in parts of N.E. Rhodesia and Nyasaland, but is found as far South as the Northern Transvaal and Zululand, districts hitherto regarded as immune, owing to the absence of that old offender, *G. palpalis*.

"In matter-of-fact tones Mr. Stephens remarked that he had called the new trypanosome after Rhodesia, whence it came, adding drily that Rhodesians did not seem to appreciate the compliment. 'I tell them,' said the Doctor, and the faint smile died away from the grave face, 'if they do not like it, the best thing they can do is to get rid of it—free the country from it as quickly as they can.'"

It is somewhat difficult to believe that these statements and opinions can have emanated from so distinguished a scientist as Dr. Stephens, inasmuch as they are far from accurate, and are calculated to bring unfair discredit upon Rhodesia.

In the first place it is scarcely correct to state that Dr. Stephens, "working in Liverpool, had just discovered a new sleeping sickness trypanosome," since the credit belongs to those medical men who, in 1909, investigated the first cases in Northern Rhodesia and placed on record the extreme virulence of the disease.

The first exact study of the trypanosome was conducted by Bevan—the Government Veterinary Bacteriologist of Southern Rhodesia—who, in 1909, first established a strain of parasite at his laboratory and infected with it not only rats, rabbits and guinea-pigs, but sheep, goats and a mule.

As the results of these experiments, during the latter part of 1909 and early part of 1910, he presented contributions* to various scientific publications drawing attention to:—

(1) Unusual virulence of the strain in laboratory animals as compared with *Trypanosoma gambiense*, thus confirming the opinion of medical officers in the field.

(2) Susceptibility of domestic animals, periods of incubation and duration of the disease in them, and the fact that these animals, when artificially infected with the parasite, suffered from a more acute disease than when inoculated with the ordinary animal trypanosomes of the country.

(3) Morphological features of the parasite, including an observation that "the macronucleus is round or slightly oval, and is situated centrally or slightly posterior to the centre."

(4) A certain extraordinary swelling of the face of sheep and rabbits distinguishing the disease from that caused by animal trypanosomes.

This investigator was evidently conscious of the fact that he was dealing with a trypanosome of unusual type, inasmuch as he entitled his first report to the *Journal of Comparative Pathology and Therapeutics*, June 1910, "Note on the Passage of a human Trypanosome through Domestic Animals," instead of making use of the old name *Trypanosoma gambiense*, hitherto regarded as the sole cause of sleeping sickness.

The only circumstance which would justify Dr. Stephens in his claim to have discovered a new trypanosome lies in the fact that later, when the patient which afforded the strain of the trypanosome in Bevan's laboratory was sent to Liverpool, small animals which were inoculated from him revealed some unusual types of trypanosome, inasmuch as their nucleus was situated posterior to the centrosome.

But in view of the fact that many circumstances, as, for example, unnatural hosts and environments, artificial passage and unnatural methods of transmission, are known to exert a marked influence upon the shape of trypanosomes, such a minor feature as that pointed out by Dr. Stephens scarcely justified the recognition of a new species. In spite of the fact pointed

* *The Journal of Comparative Pathology and Therapeutics*, vol. 23, part 2, June, 1910. *The Journal of Tropical Medicine and Hygiene*, January 16, 1911. THE VETERINARY JOURNAL, January, 1911.

out by Bevan and other observers concerning the exceptional virulence of the organism, its effects upon domestic animals, its resistance to atoxyl, and the unusual clinical symptoms produced in sheep and rabbits, there are still authorities who favour the belief that the organism is merely a variety of *T. gambiense* modified by unusual conditions, and that the results obtained in European laboratories are of necessity artificial or unnatural.

According to the newspaper report, Dr. Stephens does not appear to realize the harm he may have done to Rhodesia by his over-hasty naming of the trypanosome.

The greatest need of that magnificent country is population, and it is unlikely that settlers, or, at any rate, those of the right class, *i.e.*, men with a certain amount of capital, are likely to be tempted to invest their money in a country which is advertised as the home of sleeping sickness. The name does not discriminate between Northern and Southern Rhodesia, although in the former, up to the present, not a single case has arisen. It is indeed a case of "give a dog a bad name and hang him," and the protest of Rhodesians surely merits more earnest consideration on the part of Dr. Stephens than that which he is reported to have given it.

Lastly, it would appear that Dr. Stephens takes it for granted that *G. morsitans* is the natural transmitter of the disease. In spite of the fact that Dr. Kinghorn, working in Northern Rhodesia, has recently succeeded in transmitting the trypanosome by means of this fly under artificial conditions, there are many indications that it is not the natural means of the dissemination of the disease.

For, seeing that the lower animals as well as man are likely to serve as a reservoir of virus of exceptional strength, that hosts are abundant, and that the suspected fly is widely distributed in vast numbers and in conditions which are evidently suitable for the development of the trypanosome, it is surprising that the disease is so rare and so strictly located. One would have expected it to have spread as a veritable plague throughout the Luangwa Valley, and possibly throughout the Colony, instead of showing, as it does, a tendency to disappear.

Before important and damaging theories are allowed publicity they should be thoroughly tested in the laboratory, and when, as in the present instance, so much is at stake, the

greatest care should be taken to ensure that laboratory results conform with the conditions obtaining in Nature.

The too hasty generalization from special instances is to be deprecated.

EXPERIMENTS TO DETERMINE THE SAFE DOSE OF WHITE ARSENIC, COOPER'S DIP, AND BLUE-STONE FOR SHEEP.

By Dr. ARNOLD THEILER, C.M.G.
Acting Director of Veterinary Research, Pretoria.

The drugs mentioned in the title of this paper are frequently used in South Africa for the treatment of many diseases in all classes of domesticated stock, both with the object of prevention and of cure. These drugs are, however, more particularly in vogue for the treatment of sheep affected both with wire-worms and tape-worms. In addition, Cooper's Dip is widely known, and has a well-established reputation as a preventive for geelziekte.

On looking through the South African literature the writer has noticed that the toxicology of these various drugs has never been properly worked up, and no reliable data are to be obtained as to the maximal and minimal doses of any of these drugs.

Taking these facts into consideration, and knowing that the drugs are undoubtedly effective in the treatment of sheep for wire-worms, either separately or jointly, the writer was induced to undertake an unusually large series of experiments on sheep, with the object of arriving at the maximal reliable dose of these drugs, and of the mixtures which come into consideration. These investigations were undertaken with the powdered drugs, as experience has proved that even with extreme care the administration of the liquid bluestone, &c., to sheep occasionally leads to accident, owing to the solution passing into the lungs. The use of the powdered form excludes the possibility of similar misfortunes.

The Drugs.

(1) White arsenic, or arsenious oxide, is a remedy of old standing. It is a whitish powder and has a rather high specific

gravity. It dissolves slowly in cold water in the proportion of one part of arsenic in sixty parts of cold water, but it is easily soluble in alkaline and acid solutions.

(2) Cooper's Dip is a proprietary drug, the composition of which has, to the writer's knowledge, never been published by the manufacturer. Its chief constituents are, however, arsenic combined with sulphur and alkalies. According to Dr. Juritz the arsenic is probably present in the form of soluble compounds, such as sodium arsenite and sulph-arsenite.

(3) The chemical name for bluestone is sulphate of copper, and is recognized by the large transparent blue crystals, which are easily soluble in cold water. After exposure to the dry atmosphere the crystals desiccate, and appear to be covered with a white powder.

When ordering bluestone for medicinal purposes, it should be asked for by its chemical name, "sulphate of copper," and, before using, it should be properly examined.

When the writer was ordering bluestone from wholesale firms it happened that quite a different article was supplied, viz., sulphate of iron, and, when asked for an explanation the suppliers stated that this drug commercially goes under the name of "bluestone."

Sulphate of iron is distinguishable by the greenish crystals, but many samples of sulphate of copper contain a considerable quantity of iron sulphate. Such material should always be rejected.

All the following experiments were undertaken with weighed-out quantities, the unit of weight being the metric gramme (1 gramme = 15 grains). As this measure is, however, not in common use in South Africa, the weights have all been converted to grains, ounces, and pounds (avoirdupois). The following is the scale of weights to be adopted by the farmer in weighing out any of the materials referred to.

Avoirdupois Weight.

437½ grains = 1 oz.
16 oz. = 1 lb. (or 7,000 grains).

Note.—The drachm weight has been omitted in order to prevent confusion between the "apothecaries" and the "avoirdupois" weights.

Age and Weight of the Experimental Sheep.

The sheep referred to in the following experiments were of all ages, although there was a preponderance of 2-tooth and full-mouth sheep compared with the 4 and 6-tooth animals.

Roughly speaking, for each 4-tooth sheep there were two 2-tooth, one 6-tooth, and two full-mouth sheep.

Their weights varied from 35 to 80 lb., the average being 60 lb.

PART I.—EXPERIMENTS WITH WHITE ARSENIC.

Experiment No. 1.—To find the Fatal Dose of White Arsenic for Sheep.

Sixteen sheep received varying doses of arsenic, the results being as follows:—

Weight (grains) ...	7½	15	30	45	60	75	90	105	120	135	150
No. of sheep dosed	2	3	3	1	1	1	1	1	1	1	1
No. of sheep that died	0	0	0	0	0	0	0	0	0	0	0

Conclusion.—The remarkable and almost incredible fact is noticed that, in this experiment, none of the dosed sheep died; the extraordinarily high dose of 150 grains of white arsenic had no ill-effect. This experience led to the supposition that the drug used in the experiments was not pure asenious oxide. A sample was, therefore, submitted to the Chemical Analyst, who, after analysis, pronounced it to be pure white arsenic, and all doubts were accordingly removed.

Experiment No. 2.—*To find the Optimal Dose of Arsenic for a number of Sheep, viz., the dose which can be given without the risk of poisoning them.*

Note.—Since the watering of sheep previous to and after dosing is of considerable importance in the effect of the drug, the experiment was carried out in two sections.

I.—Dose of 15 *grains of White Arsenic:* (*A*) Sheep watered twenty-eight hours previous to and immediately after dosing. Fifteen sheep were treated on June 6, 1911. *Result:* No ill-effects and no deaths occurred. (*B*) Sheep watered twenty-eight hours previous to and twenty-four hours after dosing. Fifteen sheep were treated on June 15, 1911. *Result:* No ill-effects and no deaths occurred.

II.—Dose of 30 *grains of White Arsenic:* (*A*) Sheep watered

twenty-eight hours previous to and immediately after dosing. Fifteen sheep were treated on June 6, 1911. No ill-effects and no deaths occurred. (*B*) Sheep watered twenty-eight hours previous to and twenty-four hours after dosing. Fifteen sheep were dosed on June 6, 1911. No ill-effects and no deaths followed.

III.—Dose of 45 grains of White Arsenic: (*A*) Sheep watered twenty-eight hours previous to and immediately after dosing. Fifteen sheep were treated on June 6. No ill-effects and no deaths ensued. (*B*) Sheep watered twenty-eight hours previous to and twenty-four hours after dosing. Fifteen sheep were treated on June 6, 1911. No ill-effects and no deaths followed.

IV.—Dose of 60 grains of White Arsenic: (*A*) Sheep watered twenty-eight hours previous to and immediately after dosing. Fifteen sheep were treated. Two sheep died; one on the seventh, and the other on the eleventh day. The death of these two animals was due to peritonitis. (*B*) Sheep watered twenty-eight hours previous to and twenty-four hours after dosing. Fifteen sheep were dosed on June 6, 1911. No ill-effects and no deaths occurred.

Summary of Results.—Arsenic in the dose of 15, 30, and 45 gr. had no ill-effect on ninety sheep, either when they were watered twenty-four hours after dosing or when they were watered immediately after dosing.

In the dose of 60 gr., arsenic caused the death of two sheep of the lot of fifteen which were watered immediately after dosing, but no ill-effects were noted in the batch that were watered twenty-four hours after dosing.

Conclusions.—It appears that arsenious oxide in the dose of 15, 30, and 45 gr. is a safe dose for sheep, but it would not be wise to use the largest dose on a great number of sheep.

Part II.—Experiments with Cooper's Dip.

Experiment No. 3.—To find the Fatal Dose of Cooper's Dip for Sheep.

Eleven sheep received varying doses of Cooper's Dip, the results being as follows:—

Weight of Cooper's Dip (grains)	15	30	45	67½	135	180
No. of sheep dosed	2	2	2	3	1	1
No. of sheep that died	0	0	0	1	1	1

Conclusion.—Cooper's Dip killed the two sheep which received the extraordinarily large dose of 135 and 180 gr., the cause of death being gastro-enteritis. Of the three sheep which were dosed with 67½ gr., one died twenty-two days after the administration of the drug from gastro-enteritis.

The safe dose would, therefore, appear to be below 67½ gr.

Experiment No. 4.—To find the Maximal Dose of Cooper's Dip which can be given with safety to a number of Sheep.

Summary of Results.—(1) Cooper's Dip administered to sheep in the doses of 15 gr. had no fatal effect on thirty sheep. The fifteen sheep belonging to the lot of "watered twenty-four hours previous to and after dosing" were noticed to be "off feed" the day following.

(2) With the dose of 30 gr., forty-eight sheep were dosed, and one died the following day.

(3) With the doses of 45 gr., thirty sheep were dosed, and four died. Two of the sheep died within forty-eight hours. They belonged to the lot "watered immediately after dosing." Two died on the 7th and 8th days respectively; these latter were watered twenty-four hours after dosing.

(4) With the dose of 60 gr., thirty sheep were treated, and of these fourteen out of fifteen of the lot which were "watered immediately after dosing" died, death taking place, with one exception, within forty-eight hours. Of the lot "watered twenty-four hours after dosing" six died, and, with one exception, death took place within forty-eight hours.

Conclusions.—It appears to be safe to give Cooper's Dip in the dose of 15 gr. to sheep either when they are watered or not watered after dosing.

A mortality of 2.1 per cent. occurred in sheep which were dosed with 30 gr.; about 25 per cent. of the sheep showed symptoms of disturbance by refusing to feed.

A mortality of 13 per cent. occurred in sheep which were dosed with 45 gr., and the survivors showed distinct symptoms of illness.

A remarkable fact is noted here, that the sheep watered immediately after dosing died within twenty-four hours; those watered after twenty-four hours died only seven and eight days later.

Amongst the sheep dosed with 60 gr., the greatest mortality

(93 per cent.) occurred amongst the lot watered immediately after dosing, and a smaller mortality (40 per cent.) was noted in the lot which were watered twenty-four hours after.

The dose of Cooper's Dip which can be given with safety appears to be 15 gr.

Part III.—Experiments with Bluestone.

Experiment No. 5.—To find the Maximal Dose of Bluestone which can be given with safety to a number of Sheep.

Summary of Results.—(1) Of thirty sheep dosed with 22½ gr. of bluestone none died.

(2) Of thirty sheep dosed with 45 gr. of bluestone three died of the lot "watered twenty-four hours after dosing."

(3) Of thirty sheep dosed with 67½ gr. six sheep died—three of each lot.

(4) Of thirty sheep dosed with 90 gr. bluestone fifteen died, of which eight belonged to the first, and seven to the second lot.

Conclusions.—The dose of 22 gr. bluestone appears to represent a safe dose for sheep; it may probably be slightly increased.

The dose of 45 gr. and more may cause death.

It seems to be immaterial whether the animals are watered directly after dosing, or only twenty-four hours later.

Part IV.—Experiments with a Mixture of Bluestone and White Arsenic.

It having been found that white arsenic may apparently be given in the dose of 15, 30, and 45 gr., and a safe dose of bluestone may be slightly above 22½ gr., it was decided to experiment with a combination of the two optimal doses.

Experiment No. 6.—To find the Maximal Dose of a Mixture of Bluestone and White Arsenic that can be given with safety to a number of sheep.

Of forty sheep dosed with a mixture of 15 gr. of white arsenic and 15 gr. of bluestone, none died.

Conclusion.—The dose of 15 gr. of white arsenic, mixed with 15 gr. of bluestone, seems to be a safe dose for sheep.

The mixture of 30 gr. of white arsenic and 15 gr. of bluestone caused the death of one sheep out of forty (2.5 per cent.).

Conclusion.—The dose of 30 gr. of white arsenic and 15 gr. of bluestone does not appear to be a safe dose for sheep.

Summary of Results.—Of sixty-six sheep dosed with a mixture of 30 gr. of white arsenic, added to 30 gr. of bluestone, five were killed, owing to a prolapse of the stomach (7.5 per cent.), and one died of gastro-entritis.

Conclusion.—The dose of 30 gr. of white arsenic, mixed with 30 gr. of bluestone, does not appear to be a safe dose for sheep.

PART V.—EXPERIMENTS WITH BLUESTONE AND COOPER'S DIP.

Experiment No. 7.—To find the Maximal Dose of a Mixture of Bluestone and Cooper's Dip which will not cause death.

Experiment No. 8.—To test the apparently safe dose of Cooper's Dip and Bluestone on a number of Sheep.

Summary of Results (Experiments Nos. 7 and 8).—(1) One hundred and forty-seven sheep were dosed with 15 gr. of bluestone and 15 gr. of Cooper's Dip, and none died of the effect of this dose. One of the experimental sheep succumbed after dosing from accidental causes.

(2) Six sheep were dosed with 22½ gr. of bluestone and 15 gr. of Cooper's Dip and none died.

(3) Thirty-six sheep were dosed with 22½ gr. of bluestone and 22½ gr. of Cooper's Dip, and one sheep died of the effects of this dose.

(4) Six sheep were dosed with 30 gr. of bluestone and 30 gr. of Cooper's Dip, and one died from the effect of the dose.

Conclusion.—The dose of 15 gr. of Cooper's Dip, added to 15 gr. of bluestone, given in a mixture, seems to be a safe dose for a sheep.

PART VI.—EXPERIMENTS WITH BLUESTONE, COOPER'S DIP, SALT, AND SULPHUR.

Experiment No. 9.—To see whether an addition of Common Salt and Sulphur can be made to the Safe Dose of Bluestone and Cooper's Dip without increasing the Toxicity of the Mixture.

Note.—This addition was chiefly made to increase the bulk of the mixture with what appears to be harmless substances in order to arrive at a convenient measure in dosing the sheep.

Mixture to contain:—

1 part of Cooper's Dip;
1 part of bluestone;
1 part of sulphur;
1 part of common salt.

The dose of the mixture per sheep was calculated to be 45 to 60 gr.; in the first case sheep would get 11¼ gr. of bluestone and 11 gr. of Cooper's Dip, and in the second case 15 gr. of Cooper's Dip, and 15 gr. of bluestone would be contained in each dose of the mixture.

Summary of Results.—(1) Sixty-five sheep were dosed with 45 gr. of a mixture of Cooper's Dip, bluestone, sulphur, and salt, in equal parts, and of this lot five sheep died from poisoning (or 8 per cent.).

(2) Eighty-eight sheep were dosed with 60 gr. of the mixture, and of this lot sixteen sheep died from poisoning (18 per cent.).

Conclusion.—The addition of the non-poisonous materials, salt and sulphur, in equal parts, to an otherwise safe dose of Cooper's Dip and bluestone, appears to render the mixture dangerous for sheep. Accordingly, in a mixture which contains salt and sulphur, the maximal dose of Cooper's Dip and bluestone cannot be given, and, therefore, when the safe effect both of Cooper's Dip and bluestone is expected, it is not advisable to add any other constituents to this mixture of the two.

Experiments with Lambs.

Experiment No. 12.—To ascertain the Safe Dose of Cooper's Dip and Bluestone for Lambs.

Dose.—7½ gr. Cooper's Dip, 7½ gr. bluestone.

Experiment.—On August 10, 1911, thirteen lambs, three to six months old, were dosed with a mixture of 7½ gr. bluestone and 7½ gr. Cooper's Dip. The average weight of these lambs was 22 4/5 lb., with a maximum of 33 lb. and a minimum of 17 lb.

Result.—Six lambs died within forty-eight hours from poisoning.

Conclusion.—The dose of 7½ gr. of Cooper's Dip, added to 7½ gr. of bluestone, does not appear to be safe for lambs of three to six months old.

Note.—Unfortunately, no further lambs were available for this experiment at the time, but the question will be again taken up at an early date.

Comparison with Previous Recommendations.

In the leaflet issued by the Division of Veterinary Science in 1907, two recommendations are given for the treatment of wire-worms in sheep, one dealing with bluestone in a liquid form, and the other with Cooper's Dip in a mixture of flowers of sulphur, powdered slaked lime, and common salt.

The following comparison between the quantities recommended in the pamphlet, and the amounts which appear to be safe in the preceding experiments, is of interest.

Bluestone.—The quantities of the liquid bluestone solution (in the proportion of 1 lb. bluestone to 10 gal. of water) recommended in the pamphlet referred to above is as follows:—

For lambs three to six months old: 1½ to 2 oz., which contains 6.6 to 8.7 gr. of bluestone.

For lambs six to nine months old: 3 oz., which contains 13.1 gr. of bluestone.

For lambs nine to twelve months old: 3½ oz., which contains 15.3 gr. of bluestone.

For lambs twelve to eighteen months old: 4 to 4½ oz., which contains 17.5 to 19.7 gr. of bluestone.

For lambs eighteen months and over: 5 oz., which contains 21.7 gr. of bluestone.

It has been seen in the experiments in this paper that a dose of 22½ gr. of bluestone (dry) did not cause any ill-effects on thirty full-grown sheep, but when Cooper's Dip powder was added to the bluestone the dose had to be reduced to a mixture of 15 gr. of each.

On the assumption, therefore, that a safe dose of Cooper's Dip and bluestone combined for a full-grown sheep would be 30 gr., the dose for lambs would appear to be as follows:—

	A Mixture containing: Cooper's dip Grains	Bluestone powder Grains
For lambs three to six months old	4.4 to 5.8	4.4 to 5.8
For lambs six to nine months old	8.7	8.7
For lambs nine to twelve months old ...	10.2	10.2
For lambs twelve to eighteen months old ...	11.7 to 13.1	11.7 to 13.1
For lambs eighteen months old and over ...	14.5	14.5

Referring to Experiment No. 12, on lambs, it will be seen that a dose of 7½ gr. Cooper's Dip, added to 7½ gr. bluestone,

proved to be fatal for six lambs (varying in ages from three to six months old) out of thirteen, or 46 per cent. This would indicate that lambs are more susceptible to Cooper's Dip and bluestone than adult sheep, and this fact should be taken into consideration when dosing them. It is probable that about one-third less than the above doses would be more satisfactory, but the matter requires further experimental investigation, and this will be undertaken at an early opportunity.

Cooper's Dip.—The second prescription given in the pamphlet referred to above is the following:—

Cooper's Dip	1 part.
Flowers of sulphur	3 parts.
Powdered slaked lime	3 parts.
Common salt	30 parts.

The dose recommended is one teaspoonful of the mixture for an adult sheep, to be given daily for a week.

In other words, a full-grown sheep would receive seven teaspoonfuls of the mixture in a week, of which seven-thirty-sevenths was Cooper's Dip, or, allowing for an average teaspoon to hold 60 gr., a sheep would consume, approximately, 11 gr. of Cooper's Dip in a week.

An experiment* with licks showed that on an average a sheep consumed (by licking) 11 gr. of Cooper's Dip and 11 gr. of bluestone daily for a period extending over nearly a month, so that, on this experiment, it would appear to be safe to increase the proportion of Cooper's Dip in the mixture quoted above. Attention must, however, be drawn to the fact that the sheep should only partake of the dry lick, and in dry weather. The addition of liquid to powdered bluestone appears to increase its toxicity to a considerable extent, and, under such conditions, ill-effects may follow.

General Recommendations.

One important point that is brought out in these experiments is that a safe dose of a mixture of Cooper's Dip and bluestone, when mixed with two substances which are considered to be harmless, such as salt and sulphur, became toxic, and caused

* The experiments on licks are very instructive, but we are unfortunately unable to give them owing to want of space.—Ed. *V. J.*

death amongst the treated sheep. It is also possible that local conditions on the different farms may influence the toxicity of the mixture; certain farms are more brackish than others, and it is quite within the bounds of possibility that the salts acquired by sheep grazing on such farms would increase the toxicity of an otherwise safe mixture.

The application of the drugs referred to in this article for the treatment of worms in sheep will be dealt with in a future publication.

Appendix.

The Post-Mortem Lesions of Arsenious Oxide Poisoning.

There were only two sheep which died of poisoning from arsenious oxide.

The *post-mortem* examination in each case revealed that poisoning with arsenious oxide produces a cauterization of the mucous membrane of the fourth stomach, as a result of which perforation may ensue, and the contents of the stomach escape into the peritoneal cavity, causing peritonitis.

The lesions of gastro-enteritis and nephritis in both cases are probably of a secondary nature, and are due to a septicæmia consequent to the peritonitis.

Post-Mortem Lesions of Cooper's Dip Poisoning.

In cases of poisoning by Cooper's Dip death occurred in the majority of instances within the first twenty-four hours after dosing; in some cases forty-eight hours elapsed, and only on a few occasions did death occur after an interval of a few days. We may, therefore, from a clinical point of view, distinguish an acute poisoning, where death occurred within the first forty-eight hours, and subacute poisoning where it occurred after a longer period.

Conclusion.—Cooper's Dip is a substance which apparently is easily and quickly absorbed and distributed throughout the whole system. It affects all organs, causing an inflammation of the stomach and the intestines, a swelling of the liver, which is found on microscopical examination to be due to stasis of the blood, this being accompanied by a fatty degeneration of the peripheral portion of the liver lobules. A swelling of the spleen and an inflammation of the kidneys are frequently noted.

Subacute poisoning with Cooper's Dip is accompanied by the same lesions.

POST-MORTEM LESIONS OF BLUESTONE POISONING.

The majority of sheep died within twenty-four hours, and a few within thirty-six hours.

Conclusion.—Bluestone apparently affects the mucous membrane of the mouth and of the omasum to a certain extent, but it has a distinct action on the mucosa of the abomasum, where it forms a greenish deposit, cauterizing the underlying mucosa, causing a severe inflammation and erosion of the superficial layer. Similar to Cooper's Dip, it is absorbed into the system, and produces a fatty degeneration of the liver, a swelling of the spleen, and inflammation of the kidneys.

POST-MORTEM LESIONS FOUND IN SHEEP WHICH DIED AFTER DOSING WITH A MIXTURE OF ARSENIOUS OXIDE AND BLUESTONE.

Clinically, two forms must be distinguished, the acute poisoning, where death occurred within the first ten days after dosing, and chronic poisoning, when death ensued after the lapse of some weeks (nineteen days, twenty-four days, one month, and five weeks respectively).

The Acute Cases.—Acute poisoning (two cases: one after an interval of thirty hours, and one after three days).

The lesions were those of acute gastro-enteritis, and resembled those described under bluestone poisoning.

The Chronic Cases.—The characteristic lesion was the prolapse of the fourth stomach through an orifice in the abdominal wall. At the place where the prolapse had occurred was a corresponding orifice in the wall of the abomasum, so that the mucosa was exposed to the outer air. The mucosa of the abomasum was thickened, diffusely hyperæmic, covered with coagulated blood, and soiled with earth, showing erosions, and in some cases extensive ulcerations.

Note.—None of the animals died. As soon as the above conditions were noticed the animals were killed.

Conclusion.—The typical lesions in combined arsenical and bluestone poisoning seemed to be an ulceration of the mucosa of the fourth stomach, which penetrated through the wall of the abdomen, causing an opening through which the everted stomachs prolapsed.

It was noticed before that arsenious oxide causes similar

ulcerations, but the joint actions of the two corrosives is probably responsible for the severe lesions.

POST-MORTEM LESIONS FOUND IN SHEEP DOSED WITH BLUESTONE AND COOPER'S DIP.

The *post-mortem* lesions were those of a gastro-enteritis, as already described under Cooper's Dip poisoning; the same lesions were also found in the sheep which died after an addition of sulphur and salt had been made.

[The full details of these experiments can be seen in the March issue of the *Agricultural Journal for the Union of South Africa,* from which the above has been abstracted.

THE NASO-PALATINE APERTURES, JACOBSON'S ORGAN, AND STENSON'S CANAL.

(*Continued from p.* 259.)

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THE HORSE.

THE body of the horse is the one usually chosen for dissection in the study of comparative anatomy by the veterinary student; and in this animal, Stenson's canal, like so many other parts of the body, is specialized. The horse differs from every other animal I have up to the present examined in regard to the disposition of Stenson's canal (in which I believe he agrees with Man, another specialized being as regards this particular organ) and the anterior naso-palatine apertures.

The anterior naso-palatine aperture in the horse differs from that of all other animals I have examined, and in this animal it might rightly be called a "cleft."

It varies in length, apparently irrespective of age (*i.e.*, of course after maturity) and breed, from 1½ in. to 2 in., and it is barely ¼ in. wide—it gradually tapers behind to a sharp point; in front it is also pointed, but rounded and smooth, and going forward from it is a smooth canal in the bone which leads to a rounded depression; these smooth canals and depressions in the bone are for the reception of the two prolongations of the septum nasi which I shall describe

later. The incisive foramen, when there is only one, is placed between these two depressions.

The maxillo-premaxillary suture or, what is about the same thing, the canine tooth, marks about the centre of the aperture.

From the region of the canine teeth there is almost always, in the dry skeleton, a slight separation between the two premaxillary bones extending backwards to their posterior extremities, and also others between their palatal processes and the maxillaries, fitted in with fibrous tissue in the fresh subject, which is all that separates the erectile tissue of the nose and palate.

The cruræ of the septum nasi pass through and fill up the

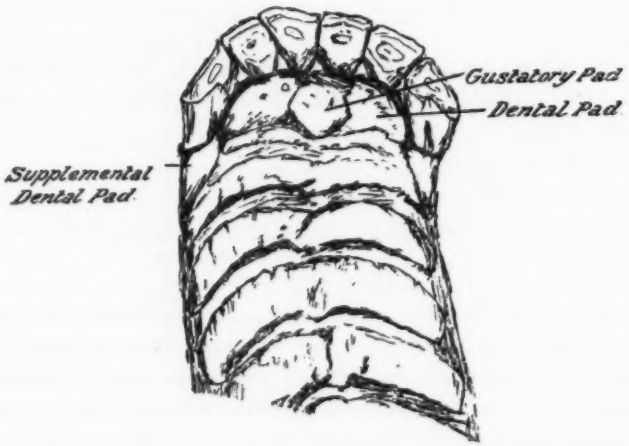

FIG. 7.—Dental and gustatory pads of horse.

anterior naso-palatine apertures as described above, and on the palatal surface of the bone they approach each other in the form of a crescent.

The alveolar portion of the premaxillæ of the horse is much arched on the oral aspect—leaving a large and deep fossa which is occupied in life by a network of venous trabeculæ or erectile tissue.

In the nasal aspect the inner edge of the anterior naso-palatine aperture is raised.

Palate.—The dental pad of ruminants is represented in the horse by a very flaccid cushion, which, with the gustatory pad, occupies the arc behind the incisor teeth ; there is a narrow space between

the pad and the alveolar edges of the bone, and a process of the buccal membrane is extended into each interdental space, thus forming a pocket behind each incisor. Its posterior boundary is formed by a small supplemental "bar," on either extremity of which there is generally seen a small supplemental pad behind each corner incisor. Taken altogether it is half-moon shaped, without the small "bar" it is somewhat the shape of a bird with extended wings—the gustatory pad forming the body and the dental pad the wings (see sketch).

The gustatory pad is pentagonal, and, situated behind the central incisors, occupies the middle-third of the dental pad, from which it is separated on either side by a deep fissure.

The gustatory and dental pads are alike in structure, and very loosely attached to the venous trabeculæ underlying them: these pads and the spaces between the first four bars are pink in colour, all the rest of the palate is white. On very close inspection there appear to be several small openings, the size of pin-points most of them, scattered over the dental and gustatory pads and the first five bars, and a few on the next four bars.

Though there is no actual opening of Stenson's canal in the palate of the horse, the important point is, these small openings are scattered most thickly over the buccal membrane covering the erectile tissue in which the naso-palatine nerve is distributed anterior to the blind termination of Stenson's canal, and, from its appearance, I should imagine that all the dental pad of the horse is gustatory.

There are seventeen bars proper, with a supplemental one behind the dental pad, and another on the posterior edge of the palate.

Of these, seven occupy the diastema between the last incisors and the first molars; these are all continued across from side to side of the palate, and increase in breadth from the first to the seventh; they curve forwards from the sides and are inflected backwards at their centres by a slight eminence on their posterior margins; from the eighth to the seventeenth, which occupy all the palate between the molars, they gradually diminish in breadth, and are interrupted at the centre of the palate where they curve backwards.

Behind the seventeenth is a single raised ridge going from side to side of the palate, behind the last molar, and describing a semicircle forwards, making the boundary of the soft palate which hangs down behind it.

The palate is very loosely attached to the subjacent tissues as far back as the eighth bar ; behind this it is firm, and under the last six bars it is very firm and immovable. The "bars" are rather loose and discontinuous at their centres ; one seems to be capable of moving on the other by loose tissue placed at the posterior edge of each, enabling the one in front to partly lap over the one behind it.

Between the buccal membrane and the bone is a large network of venous trabeculæ, probably erectile tissue.

By very careful dissection, Jacobson's organ may be traced as beginning in the erectile tissue of the palate ; it passes through the anterior naso-palatine aperture ½ in. behind the canine tooth, and so to the bulging part of the septum nasi at its inferior portion. In this section, just in front of the molar teeth, the openings of the organs are seen on either side of the septum, as forming the basement of the flange, immediately above the bony floor of the nasal chamber.

Between the gustatory pad and the bone is a quantity of fibrous tissue, to which the buccal membrane is closely attached, and, in dissecting it away there appeared to be a quantity of a watery secretion.

The palatine nerve accompanying the artery gives off numerous branches to the buccal membrane and to the erectile tissue, and branches of the naso-palatine nerve are distributed under the gustatory pad.

A careful study of the disposition of these parts must bring us to the conclusion that the condition of the palate known to horsemen and the old-time veterinarians under the name of "Lampas," a supposed disease, the symptom of which is a slight protrusion of the dental pad and the gustatory organ to a little beyond the level of the biting surface of the incisor teeth, is merely a natural and normal way of bringing these parts in contact with food entering the mouth, and so allowing them to exercise their function of taste and selection. *I do not believe that this is any more a symptom of disease than is the absence altogether of the upper incisor teeth of so many ruminants, or the suppression of them in the Suidæ ; and the brutal practice of those who ignorantly mutilate these highly sensitive parts, by cutting, or even burning with a hot iron, with the idea of "curing" a perfectly normal condition of the palate, cannot be too strongly condemned.*

The anterior extremity of the septum nasi is firmly fixed into the groove between the premaxillæ.

Compared with other animals the cartilaginous alæ of the nares of the horse, with all their attachments, are markedly mobile, being attached to the septum by a thin hinge-like portion of fibro-cartilage, making them easily movable on the firm basement of the septum; then the alæ turn first forwards, then downwards, and then backwards, being only very loosely attached to the premaxillæ. The triangular space between the alæ and the anterior extremity of the septum is occupied by muscular tissues, the alæ are attached to the bones by loose fibrous tissue.

The infra-anterior border of the septum-nasi gives off a branch on either side that fill in the anterior naso-palatine apertures and end in *cul-de-sacs* under the soft palate. These rami form a very firm but elastic stay for the septum, and also the walls of Jacobson's organ.

The opening of Jacobson's organ is in the angle of the anterior margin of the floor of the nose—a distinct canal in the floor of the nose leads to it—and embraced in the cartilaginous walls formed by the rami of the septum, it passes through the anterior naso-palatine aperture, and just under the palate. At this point it appears to end in a *cul-de-sac*. From this *cul-de-sac* a probe can be easily passed into the returning canal of Jacobson's organ, which passes back under the floor of the nasal chamber and under the flange of the septum to as far as the fourth molar tooth, where it ends in a *cul-de-sac*. The walls are formed by a thin cartilage, a reflection of the ramus of the septum on the inner side, and by a thin membrane on the outer side.

Passing forward from the *cul-de-sac* of Jacobson's organ above described, in a groove formed between the inner margin of the ramus of the septum and the bone is a branch of the naso-palatine nerve, which ultimately spreads out to form filaments which blend intimately with the dental and gustatory pads and the large trabeculæ in which they rest.

Erectile tissue extends to the extreme lower margin of the channel leading to Jacobson's organ in the lower nasal meatus, and through this organ it becomes continuous with the erectile tissue of the palate.

Tapirs.

In the *Asses* and *Zebras* the anterior naso-palatine apertures are smaller than in the horse.

There is a single large anterior naso-palatine aperture centrally

placed in all the *Tapirs*, though it differs considerably in size. The roof of the anterior part of the aperture, viewed from the palatal aspect, is formed by the premaxillary bones. The somewhat pointed anterior edge of the aperture corresponds to the posterior edges of the third incisors, it widens considerably to some distance behind the canines, and then narrows again to a blunt point, making it a rough diamond shape. In front of the aperture there is a double fossa between the two large third incisors, the bone is raised again in front of the fossæ to form a ridge behind the incisors.

So far this description of the apertures applies to all the tapirs, but the posterior boundary differs considerably; thus, in *Elasmognathus bairdi*, from Costa Rica, and in a male *Tapirus roulini* from Ecuador, it extends as far back as the first premolar interdental space, giving it an elliptical shape.

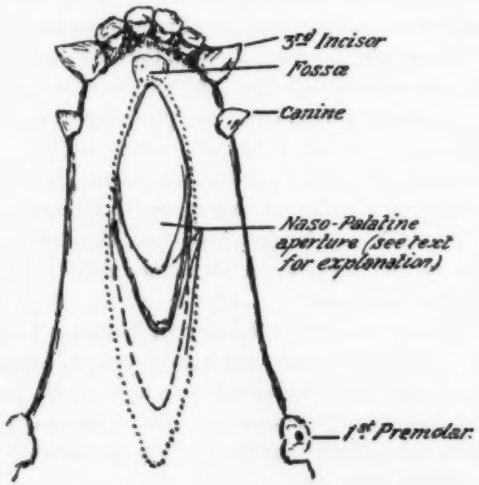

FIG. 8.—Tapir (bony palate).

In the female *T. roulini* from Ecuador, and in a *Tapirus malayanus* it extends as far back as the first premolar.

In a tapir from Demerara, one from Rio Grande, and another from South America, the aperture does not extend as far back as the first premolar.

In a *Tapirus terrestris* from Peru and in a tapir from Surinam, the posterior edge of the aperture is scarcely more than half-way between the canine and premolar.

Explanation of sketch showing the position of the anterior naso-palatine aperture and fossa in relation to the teeth :—

The dotted line shows the large aperture seen in the *E. bairdi*, and in a male *T. roulini*.

The broken line shows the outline of the aperture in a female *T. roulini*, and in a *T. malayanus*.

The thick shaded line describes the aperture in a tapir from Demerara, one from Rio Grande, and another from South America.

The plain line shows the smaller aperture of a *T. terrestris* from Peru and of a tapir from Surinam.

RHINOCEROS.

Rhinoceros unicornis, var. sumatrensis.]—A Malayan specimen. Owing to the peculiar conformation of the anterior narial openings

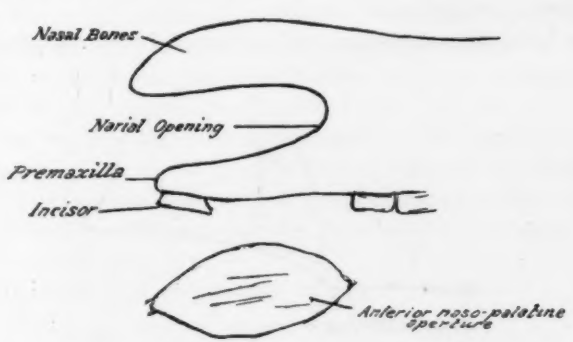

FIG. 9.—Indian rhinoceros (*R. unicornis, var. sumatrensis*). Rough sketch of side view.

in their relation to the anterior part of the palate in these animals, a study of the anterior naso-palatine apertures as being connected with the sense of taste is of especial interest, and should lead to a closer examination of Stenson's canal and Jacobson's organ when the opportunity presents itself. The nasal bones are massive and arched to support the horn, and this gives the anterior nares (in the skeleton) a very wide opening, the base of which is occupied largely by the anterior naso-palatine aperture.

In the Malayan rhinoceros the aperture is a large single one, and extends quite across the floor of the nasal chamber ; it is widest at the maxillo-premaxillary suture, anteriorly it narrows, and impinges

on the incisor alveoli ; it also narrows posteriorly to a point corresponding to the first premolars.

There is a space between the anterior margins of the premaxillary bones.

In the African rhinoceros (*R. bicornis*) the premaxillary bones are shortened back, giving the skull a snubbed appearance. The nasal bones project well forward of the pre-maxillæ ; as a consequence, as in an orthognamous man, the aperture is much smaller than in the Indian rhinoceros, though it is still single, and extends across the floor of the nasal chambers.

The edges of the vomer forming the channel for the support of the septum are wide apart, and probably the septum is proportionately massive. In one large specimen of the Indian rhinoceros there is a bony eminence over the body of the premaxilla on either side, apparently to strengthen the septum.

The Indian rhinoceros has one large upper incisor on either side

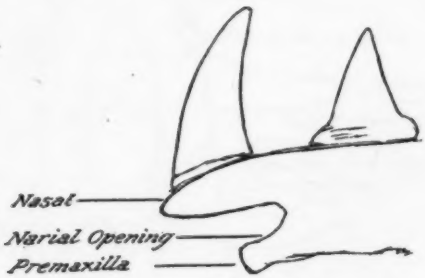

FIG. 9A.—*Rhinoceros bicornis* (African rhinoceros).

—the upper incisors are absent or quite rudimentary in the African rhinoceros.

HYRAX.

Hyrax capensis.—The anterior naso-palatine apertures are pear-shaped, and are situated one on either side of a wide raised central ridge formed by the palatal processes of the premaxillæ, their anterior edges are raised, a groove passes from each of them posteriorly and towards the centre of the palate ; they are situated just inside the maxillo-premaxillary sutures.

There is a cruciform space on the bony palate, extending forwards between the raised edges of the alveoli of the two incisor teeth,

going laterally on either side, immediately behind these raised alveoli, and being bounded posteriorly by the raised ridge on the palatal portion of the premaxillary bones.

The gustatory pad is situated in this cruciform space, being immediately behind and between the incisors.

The dental pad stands up as a prominent ridge immediately behind the two large incisors; it is formed by the first two pairs of "bars" which, curving back on themselves towards the centre of the palate, become separated from the pear-shaped gustatory pad by deep fossæ; there are a pair of papillæ in front of the gustatory pad and between the incisor teeth.

There is a central ridge in the palate behind the gustatory pad extending to between the next pair of bars.

There are twelve pairs of bars, curving forwards from the sides, and then back towards the centre of the palate, where they are discontinuous and form a groove leading backwards to the soft palate, which is studded with glandular openings, besides showing a mass of glandular structure on either side.

The oral opening of Stenson's canal is very small and situated immediately behind the papilla that is between the incisors and in the front margin of the cleft at the side of the gustatory pad.

All food would be pressed by the chisel-shaped lower incisors hard on to the gustatory pad.

The openings of the posterior nares are very small.

(*To be continued.*)

ROYAL COLLEGE OF VETERINARY SURGEONS.

Fellowship Degree.

A meeting of the Board of Examiners for this Degree was held at the College, 10, Red Lion Square, W.C., on Saturday, May 18. The following is a list of the successful candidates, together with the title of their respective theses:—

Hugh Begg, "Tympanites in Bovines."

W. A. Simson, "Bovine Pleuro-Pneumonia, Lung Sickness."

Alex. Monro, "Milk Fever."

The examiners were Messrs. J. Malcolm, W. Hunting, Professor Macqueen; Mr. Sidney Villar being in the chair.

Fred Bullock, *Secretary*.

Equine Clinicals.

AN INTERESTING CONGENITAL MALFORMATION.

By A. ERNEST WILLETT, M.R.C.V.S.,
Staines.

THE photograph shown below depicts a congenital malformation of some interest to veterinary anatomists, although an unwelcome subject to the general practitioner and to the unfortunate owner.

FIG. 1.—A malformed foal.

It is the photograph of a foal which had an excessively abnormal curvature of the spine, whilst the fetlocks of the forelegs rested completely on the ground. The animal only lived about six hours, and appeared quite cheerful until within a few moments before death, which occurred quite suddenly and unexpectedly, almost without a struggle.

SURGICAL TREATMENT OF CHRONIC ROARING IN NEW ZEALAND.

By MAXWELL EDGAR, M.R.C.V.S.,
Wanganui, New Zealand.

Case 1.—A nine-year-old thoroughbred gelding. At one time a good racehorse and the winner of many races, he was thrown out of training two years ago on account of roaring; he was unable to stay any distance and was distressed after galloping.

May 15.—Operated on the left ventricle only. The horse made an uneventful recovery and returned to exercise in a month. He was galloped at the third month and returned to training. The result is excellent; he makes no noise and has lately run prominently in three hurdle races of 1½ to 1¾ miles.

Case 2.—Four-year-old thoroughbred horse. Commenced to roar at three years old while in training, after winning a number of races; but was early in his four-year-old career thrown out of training, roaring so badly he showed distress and could not race.

May 24, 1911.—Operated on left ventricle. Returned to training quarters at third month, and was shortly afterwards galloped in my presence. Breathing decidedly noisy; but he pulled up without distress and immediately stopped "blowing." Since then trainer informs me he has much improved and is racing and working to his satisfaction.

Case 3.—Thoroughbred gelding. At one time a useful cross-country horse. Became a roarer at six years old, was taken out of training and used as a stock horse on owner's station. Became a very bad roarer and showed distress when at all pushed, and was "off feed" for one or two days after an unusually hard day with cattle.

August 1.—Operated on left ventricle only. This horse was treated out of doors, being turned out in a small paddock. Wound healed in three weeks, and the horse returned to ordinary hacking work in six weeks.

Galloped horse at third month after operation, the result being most satisfactory, though rather noisy breathing occurred when pulling very hard. He has since won in jumping contests and will again be trained for cross-country races.

Case 4.—Seven-year-old thoroughbred gelding. Hurdle racer. Taken out of training twelve months before operation on account of roaring. Exceptionally bad case and quite useless.

September 20, 1911.—Operated on left ventricle only. Wound healed about twenty-sixth day and the horse was turned out to grass. Horse was galloped on February 17; on going very freely and pulling he whistled slightly; has now been returned to training quarters.

These cases show the undoubted value of the operation on horses doing fast work. All these horses were quite useless for racing purposes, in fact, cases 3 and 4 were of little use as ordinary hacks. Other cases I have since operated on have not yet been tried.

In treating the wound I use iodoform freely inside and out. This assists granulation and prevents altogether the sometimes unpleasant smell which takes place during the first week.

AN INTERESTING EQUINE SKULL.

By J. L. PERRY, M.R.C.V.S.,
Cardiff.

The enclosed photographs show a peculiar condition of a horse's skull, a condition which must be rare in members of the equine tribe. During life two protuberances projected from the front of the skull for fully an inch, so much so that the horse was always spoken of by the local stablemen as "the horse with the horns."

The photographs show the position of the protuberances very clearly, one being taken from the front, and the second laterally. The knackerman told me that when boiling the head he lost two distinct "knobs" from them.

The horse was of the ordinary "vanner" type and only 5 years old. Death occurred from lung trouble in November last.

FIG. 1.—Front view, showing the position of the protuberances.

FIG. 2.—Side view

Canine and Feline Clinicals.

CARCINOMA OF THE SPLEEN IN A DOG WITH SUCCESSFUL EXTIRPATION.

By F. W. COUSENS, M.R.C.V.S., F.Z.S.

London, S.W.

This was a small Irish terrier, 6 years old. Weight after operation about 14 lb. Entered hospital February 25, 1910, with what was diagnosed as an internal growth. I could not obtain permission to operate until March 4. On that date the abdominal cavity was opened on the median line, and this revealed a large growth, which entirely filled the abdominal cavity, implicating the spleen, and necessitating the extirpation of the whole of that organ.

The growth, together with the spleen, weighed a little over 7 lb. after removal, and was 24 in. in circumference and 3 in. in diameter. Between 30 and 40 vessels of the omentum, &c., needed ligaturing, but the animal lost very little blood. The abdominal wall was then sutured. The ligatures and sutures were of various sizes of silk.

For a few days after the operation there was a raised temperature, which was rather variable for three days, the highest being 104° F. There was considerable thirst for a fortnight, but the appetite was fortunately fairly good. The dog was kept on Benger's food made with milk, and hæmatogen was given from the first. Juice squeezed from raw meat was allowed after the first ten days, but the dog was not put on solid food for a fortnight or more, when it had scraped raw meat, and was gradually allowed, after a month, to go back on his ordinary food, hæmatogen being discontinued.

The dog has remained in perfect health since the operation, and is alive to-day, May 15, 1912.

The growth was found to be carcinoma, and a peculiar coincidence of the case is that the husband of the dog's owner was sent into hospital with an internal growth when this dog was operated on. Shortly afterwards the man underwent an operation for the growth, which proved to be malignant, and from which operation he died.

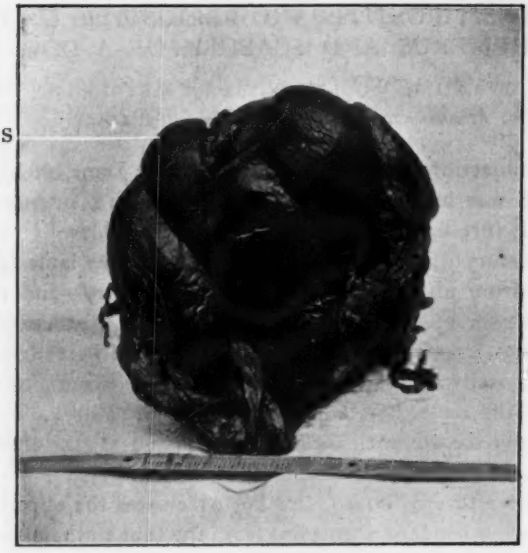

FIG. 1.—Carcinoma of the spleen. S indicates the free extremity of the spleen, which is seen to gradually merge into the growth.

FIG. 2.—Photograph of the dog 18 months after removal of the spleen and tumour.

EXTENSIVE OSTITIS AND PERIOSTITIS OF THE HUMERUS AND SCAPULA OF A DOG.

By GEO. H. WOOLDRIDGE, F.R.C.V.S.. M.R.I.A.,
Professor in the Royal Veterinary College, London.

The subject of this note was a large Great Dane bitch, 3 years old. She was brought to me on May 7, 1912, intensely lame on the left fore limb and with an enlarged shoulder.

The history of the case was that she had been lame for three months—from about the beginning of February—and had got gradually worse. There was no evidence or history of direct injury, and the owner thought she had strained herself, and contented himself with applying stimulating liniments to various parts of the limb. About the middle of March, about six weeks from the commencement of the lameness, the limb began to swell, and the owner consulted a "doggy man," who diagnosed a fracture without indicating which was the affected bone, and applied a bandage and splint from the foot to the elbow. He instructed the owner to leave it on for a month or so and then have the bandages removed. This bandage was still in position when the animal came to my observation, but the shoulder had become much enlarged.

On examination after removing the bandages I was unable to detect any lesions in the areas that had been included in the bandages, and subsequent examination of the bones proved that there had been no fracture of any of them. The shoulder, however, was found to be enormously enlarged, especially over an area with a six-inch radius from the point of the shoulder. It was firm and tense, but in the lower part pitted on pressure, and manipulation caused pain. The limb was completely paralysed, the shoulder and elbow "dropped," and the carpus and metacarpus dragged along the ground. This was apparently due in part to the considerable weight of the shoulder, but mainly to the interference with nerves of the brachial plexus by pressure of the growth. The skin was freely movable over the subjacent structures. The case reminded me of instances I had met of sarcoma of the humerus and of the femur, and I made a tentative diagnosis accordingly, and advised the lethal chamber.

The dog was accordingly destroyed, and a *post-mortem* examination made. The limb was easily detached, and there

were no abnormal adhesions to the skin nor to the chest wall. The enlargement extended a little more than half-way up the scapula and about half-way down the humerus. On cutting into it deeply spicules of bone caused a gritty feeling, and from the cut surfaces œdematous liquid escaped, but the growth did not possess the naked-eye appearances of sarcoma. Sections were cut and examined microscopically, revealing that the abnormal tissue was simply œdematous inflammatory fibrous tissue. On examining the bones the humerus was found to be the seat of

Scapula and humerus of Great Dane, showing the cavity in the humerus, and the extensive periostitis.

a rarefying ostitis and periostitis. There was a considerable cavity in the upper portion of the bone, and the periostitis extended all round the bone and down to the lower extremity in diminishing degree. The scapula was affected with periostitis on both surfaces, the supraspinatus and infraspinatus fossæ being the worst affected, but I could see no evidence of ostitis of this bone. The articular surfaces were not affected.

I am unable to account satisfactorily for the cause of the

condition, but in the absence of a history of direct violence it would appear that the condition commenced in the humerus as an ostitis and extended to periostitis. The period of lameness, for about six weeks without local swelling, appears to support that view.

There was no other lesion discovered anywhere in the body.

THE BEST POSITION FOR INCISING THE ABDOMEN WHEN PERFORMING OÖPHORECTOMY OF THE CAT.

By FREDERICK HOBDAY, F.R.C.V.S.

Kensington, W.

As in my little work on "Canine and Feline Surgery" I have made the statement that the median line is the most suitable position from which to perform the operation of oöphorectomy of the cat, I am anxious to give certain reasons why I now consider the left flank preferable. My partner, Mr. Sutton, F.R.C.V.S., and myself have operated upon fully 100 female cats within the past two years, some in the median line, some just at the lower part of the flank, and some high up in the flank in front of the muscle of the thigh. We have come to the conclusion that, in the cat at all events, the higher flank incision is by far the best. Our reasons are two—first because the cat, being an animal who (after an operation) has the habit of sitting quietly in a huddled-up position in a cage, there is less likelihood of adhesion between the fresh wound and either omentum or intestine; and secondly because, in the event of the patient suddenly becoming frightened and jumping from a height to the floor, there is less likelihood of protrusion of the intestine.

It is, however, mainly for the first-named reason, and we have noticed how very soon some of the cats begin to feed after the operation done in this situation.

The under-mentioned table illustrates fifteen consecutive cases, and is quite typical of the majority:—

In all cases chloroform was used as the anæsthetic, and tincture of iodine as the antiseptic to the skin. The latter was not washed at all, the hair being merely clipped close, and in no case, with the exception of No. 10, did the wound have to be touched again except to remove the sutures. Some had the ovaries alone

No.	Date operation performed	First meal taken voluntarily	Sutures removed	Sent home
1	February 19, 1911	February 20, night	February 24	February 25
2	,, 26, ,,	,, 27, morning	March 2	March 4
3	March 4, ,,	March 5, night	,, 10	,, 11
4	,, ,, ,,	,, ,, ,,	,, ,,	,, 11
5	,, ,, ,,	,, ,, morning	,, 9	,, 11
6	,, ,, ,,	,, ,, ,,	,, ,,	,, 12
7	,, 8, ,,	,, 9, night	,, 14	March 14
8	June 9, ,,	June 10, morning	June 14	June 15
9	,, 17, ,,	,, 18, ,,	,, 22	,, 24
10	,, ,, ,,	,, ,, ,,	,, ,,	— —
11	July 27, ,,	July 28, night	August 2	August 3
12	,, ,, ,,	,, ,, ,,	— —	,, 10
13	September 26, ,,	September 27, morning	October 1	— —
15	October 12, ,,	October 13, ,,	,, 16	October 16
14	,, 1, ,,	,, 2, ,,	,, 5	,, 5

removed, and in others ovaro-hysterectomy was performed. In no cases was any ligature used, the organs to be removed being merely scraped off slowly with blunt scissors or the edge of the scalpel. The skin alone was sutured, silkworm gut being used, thus obviating the risk of buried sutures, so often a cause of subsequent annoyance.

Abstract and Report.

JOHNE'S DISEASE.

A METHOD FOR ISOLATING AND CULTIVATING THE *MYCOBACTERIUM ENTERITIDIS CHRONICÆ PSEUDO-TUBERCULOSÆ BOVIS*, JOHNE, AND SOME EXPERIMENTS ON THE PREPARATION OF A DIAGNOSTIC VACCINE FOR PSEUDO-TUBERCULOUS ENTERITIS OF BOVINES.*

By F. W. TWORT, M.R.C.S., L.R.C.P.Lond., and G. L. Y. INGRAM, M.R.C.V.S.

(*From the Laboratories of the Brown Institution, University of London.*)

The disease of cattle described under the name of pseudo-tuberculous enteritis, or Jöhne's disease, is a serious affection which causes considerable losses to farmers and stockowners throughout the British Isles and Europe. Clinically, it is characterized by a slow progressive emaciation and chronic diarrhœa, which causes the milk-yield in cows to fall off, and often ends in death. B. Bang states that some cases show no diarrhœa, though the affected animals die; he also states that the annual losses from this disease on some of the large farms in the Islands of Denmark may amonnt to 5 to 8 per

* Abstracted from the *Proceedings of the Royal Society*, B, vol. lxxxiv. Communication received, November, 1911.

cent. of the total head of cattle. The disease may affect bovines of all ages (usually from 3 to 6 years, Meissner), but as the period of incubation has been shown to be very long, it is not usually recognized in animals which are less than a year old. It often appears in pregnant cows, and becomes aggravated after calving.

On *post-mortem* examination the lesions are found to be confined to the bowels and the surrounding lymphatic glands. The mucous membrane of the small intestine is seen to be very much thickened—in some cases it may be three or four times the normal. It is thrown into characteristic folds or corrugations, and may show areas of congestion. The large intestine and cæcum often present the same lesions. The affected glands are enlarged and œdematous, but show no caseation.

Scrapings taken from the thickened mucous membrane, and stained by Ziehl-Nielsen's method, as a rule show enormous numbers of acid-fast bacilli, though in some cases they are less numerous, and in others may be very difficult to discover.

In sections of an affected intestine the bacilli are found to be most numerous near the surface, *i.e.*, towards the lumen of the bowel. but they are also found in the villi and in the deeper layers. The increase in thickness is seen to be due to the formation of new connective tissue. "The tissue is filled with large epithelioid cells, surrounded by small round lymphatic cells, and in some cases with giant cells" (B. Bang).

The presence of an acid-fast bacillus, not to be distinguished microscopically from the tubercle bacillus, in the thickened mucosa of the bowels of cattle suffering from chronic diarrhœa, was first shown in 1895 by Jöhne and Frothingham, who considered the condition to be a form of tuberculosis, and with them Koch was in agreement.

In 1881 J. Hansen and P. H. Nielsen, of Holland, pointed out the thickening and corrugation of the mucous membranes of the intestines of certain cattle dying from chronic diarrhœa, whilst Hurtrel d'Arboval, in 1826 ("Dict. de Med. et de Chirurg. Vét."), under the head of chronic enteritis in cattle, described conditions which might well have been due to the micro-organism now known as Jöhne's bacillus. Bouley and Reynal do not seem to have recognized it as a special form of enteritis ("Dict. de Chirurg., Méd., et d'Hygien Vét.," 1860).

The disease is prevalent in many countries. Van der Sluys and Markus have described its occurrence in Holland, Liénaux and van den Eeckhout in Belgium, B. Bang in Denmark, and Borgeaud in Lausanne.

Jöhne described the first case in Dresden, and Bongert, Meissner, and others have reported many further cases in Germany. Fréger, Matthis, and Leclainche in France, and Horne in Norway, have also recognized and conducted experimental work on this disease.

In North America, the first case was described by Pearson in Pennsylvania, in 1908, and since then it has been recognized by Beebe, of Minnesota, and others.

In 1906 B. Bang, of Copenhagen, demonstrated the disease, and showed microscopic preparations of the diseased gut and glands

before the National Veterinary Association at Liverpool; he suggested that many cases of chronic diarrhœa ascribed to various intestinal strongyles were really due to Jöhne's bacillus, and predicted that the disease would be found in Great Britain, as he had in his own experience found it in tubercle-free cattle imported from Jersey.

In 1907 McFadyean described cases in this country occurring among Shorthorn, Sussex, and Jersey cattle, and, later, observed one case in a deer. In 1909 Stockman, whilst investigating a disease of sheep in Scotland, known locally as "scrapy" or "scrapie," found acid-fast bacilli in lesions corresponding to those of Jöhne's disease. Previous to this, in 1907, Liénaux attempted to inoculate the disease in sheep, but was apparently unsuccessful.

In 1909, in the Report of the United States Bureau of Animal Industry, mention is made by Dr. J. Mohler of an attempt to cultivate the bacillus of Jöhne's disease from specimens received from California, but it is clear from the details given that the specific bacillus was not grown.

Many attempts have been made to produce this disease experimentally in cattle and in the usual laboratory animals. As far as can be ascertained, in no animal, except cattle, has inoculation proved successful. Meissner and Trapp state that they have only been able to produce the disease in calves. This they have done, as also has B. Bang, by intravenous and intraperitoneal inoculation of large quantities of infected material, and also by feeding calves with considerable quantities (1 lb. to 3 lb.) of the mucous membranes of the intestines of cattle dying from this disease. Experiments of a similar nature on mice, guinea-pigs, rabbits, sheep and goats have all proved negative. In many instances the results have caused confusion, since the material used has been taken from animals also suffering from tuberculosis, and this strengthened the theory that the condition was a form of tuberculosis affecting the bowels and surrounding lymphatic glands, but showing no tendency to caseation. B. Bang, by feeding a calf with 300 grm. of affected material, found that the animal showed signs of diarrhœa in eight months, and this evidence of the long period of incubation has been supported by other observers.

All writers on this disease state that the causative micro-organism cannot be cultivated outside the animal body. Meissner, however, obtained on a decoction of grass (*Phleum pratense*) and glycerine agar a pure culture of an acid-fast bacillus which Koch and Rabinowitsch declared to be identical with the bacillus of avian tubercle. Mettam also, in a private communication, states that he has sub-cultured for twelve generations an acid-fast micro-organism obtained from a cow suffering from Jöhne's disease, and that it agrees in every respect with the avian tubercle bacillus. These must be regarded as cases of accidental contamination with the avian tubercle bacillus.

Most authors agree that animals suffering from this disease give no reaction with ordinary diagnostic tuberculin, but O. Bang has obtained in some cases a more or less decided reaction with avian tuberculin. In this country Male, of Reading, has since used avian tuberculin prepared by Stockman. He tested nineteen cattle,

giving 5 c.c. doses of tuberculin, and in four cases obtained a reaction of 3·6°, 3°, 4°, and 2·8° F. respectively. He does not state, however, whether the pre-inoculation temperature given is that of the morning or evening, and it must be remembered that both Meissner and Mettam have obtained avian tubercle bacilli from the intestine of cows infected with Jöhne's bacillus.

In June, 1910, we started some experiments with the object of cultivating Jöhne's bacillus and of preparing a diagnostic vaccine from the culture obtained. A preliminary note on the results of this work was included in a paper by one of us on the cultivation of the lepra bacillus of man, published in 1910.

We have to thank Mr. Brennan de Vine, of Birmingham, and Mr. D. Hamilton, of Hamilton, for the pathological specimens used in these experiments.

Portions of infected intestine and glands were obtained in as fresh a condition as possible, but owing to the time taken in transit, some of the specimens were found to be contaminated in the deeper tissues, and it was found necessary to kill off these contaminations with a solution of ericolin—a method which was originally devised for isolating tubercle bacilli. The gut and glands were thoroughly washed in water, and the surface of an infected area seared with a hot spatula ; microscopic films were made from the tissues beneath to prove the presence of the specific bacillus. Small pieces of tissue were then removed with sterile scissors and rubbed over the culture medium to be tested, either directly or indirectly, after being incubated in a 1 per cent. watery solution of ericolin for one to two hours at 37° C.

The first case received from Mr. de Vine, on June 15, 1910, showed the typical lesions of pseudo-tuberculous enteritis, and contained a large number of acid-fast bacilli. The specimen was fresh, and cultures were made directly on to all the ordinary laboratory media. Fresh extracts of various glands and organs (including the intestine) of normal bovines were also prepared, and sterilized by passing through a Doulton white filter. The extracts thus sterilized were placed in sterile tubes plugged with cotton wool, and inoculated with the diseased material. Small sterile portions of bovine organs were also obtained, placed in sterile tubes, and inoculated. The above media were tested in various combinations, both with and without glycerine, cholesterin, various sugars, fresh blood, and other substances. The cultures were made aërobically and anaërobically at 39° to 40° C. On none of these media were we able to obtain any definite growth of the specific bacillus.

Some experiments were also conducted to test the possibility of an ultra-microscopic virus working in symbiosis with Jöhne's bacillus. Extracts of bovine intestine infected with the disease were prepared and passed through a Doulton white filter. The sterile filtrate so obtained was added to the various media, and the whole inoculated with portions of intestine containing living Jöhne's bacilli. These experiments all gave negative results.

From the experiments conducted on this case we came to the conclusion arrived at by most other workers, namely, that the specific bacillus would not grow on any artificial medium known to bacteriologists, and that if successful cultivation were to be achieved some

new medium would have to be prepared. We considered also that the failure of growth of the specific bacillus must be due either to some substance in the medium acting as a poison, or to the absence of some material or foodstuff necessary for its vitality and growth.

On considering the question further, we were struck by the apparent close relationship existing between this micro-organism and the tubercle bacillus; and since the bacillus of pseudo-tuberculous enteritis and the tubercle bacillus both grow in the same species of animal, we considered it highly improbable that there could be any substance in the ordinary laboratory media which would act as a poison to the one bacillus and not to the other. This possibility was accordingly excluded, and we were forced to conclude that the failure to grow the bacillus must be due to the absence of some necessary foodstuff.

Considering again the apparent close relationship between the tubercle bacillus and the bacillus of pseudo-tuberculous enteritis, and the fact that both these bacilli live in the bodies of bovines, we judged it probable that they would require the same chemical substances for building up their protoplasm, certain of which substances could be elaborated from artificial media by the tubercle bacillus, but not by the bacillus of pseudo-tuberculous enteritis—in other words, that the latter bacillus has lived a pathogenic existence from such remote ages, that it has lost the original power of its wild ancestor—whatever bacillus that may have been—and can no longer build up all its necessary foodstuffs outside the animal body.

It was thought probable that if these substances could be obtained ready formed and added to some good artificial medium (Dorset's egg medium), the bacillus would grow, and further, that these substances might be elaborated by allied micro-organisms, such as the tubercle bacillus, and even stored up as reserves in their envelopes. On this reasoning, which led to the successful cultivation of the lepra bacillus of man, we decided to prepare media containing these allied bacilli which had been killed by heat.

We had at the time in our possession about three hundred strains of tubercle bacilli, mostly isolated from human tuberculous material on Dorset's egg medium. A number of these cultures were taken, and after the necessary sub-cultures had been made, they were killed by steam. The growth was then scraped off, taking care to avoid any admixture of the medium which might contain the waste products of the bacillary growth and be toxic to the bacillus of pseudo-tuberculous enteritis. More recently we have found this precaution to be unnecessary. The growth of tubercle bacilli thus obtained was ground in a mortar with glycerine and saline, steamed for half an hour, and added to the yolk and white of new-laid eggs in the following proportions: Egg 75 parts, 0·8 sodium chloride in re-distilled water, 25 parts; these were thoroughly mixed, and to the mixture were added tubercle bacilli 1 per cent. and glycerine 5 per cent. This medium was placed in sterile test-tubes, these were plugged with cotton wool and heated in a hot-water bath at 60° C. for one hour on three successive days, the tubes being incubated at 37° C. for six to twelve hours in the intervals between steaming. Finally the tubes were inspissated in slopes at 85° to 90° C.

A second case of pseudo-tuberculous enteritis was now obtained from Mr. de Vine. Specimens of intestine and glands were received on July 28, 1910. Both the intestine and glands showed the typical characters of the condition, and a large number of Jöhne's bacilli were present in various parts of the tissues. Unfortunately, owing to the hot weather prevailing at the time, the specimens on delivery had commenced to decompose, but, in spite of this, we prepared some cultures in the manner previously described, both directly and indirectly after treating with ericolin solution. The cultures were made on several of the media tested with the first case, as well as on a number of tubes of the special tubercle bacillus medium. The tubes were capped with gutta-percha tissue and incubated at 39° to 40° C. After two days' incubation all the direct cultures were badly contaminated, yet those inoculated with ericolinized material showed only a few contaminating colonies. Sub-cultures were made from uncontaminated areas of most of the latter tubes on to fresh tubes of the same media, but, owing to the small amount of the tubercle bacillus medium then prepared, only one of these tubes was sub-cultured—this was one made from a gland. Films from these sub-cultures were prepared at intervals of about four or five days, and examined microscopically. After nineteen days the sub-culture on the special medium showed quite definite evidence of multiplication, the bacilli had grown larger and thicker, they were well stained, and were present in large close masses. Sub-cultures were made from this tube on fresh tubes of various media, including one tube of the special tubercle bacillus medium. These were examined at intervals as before, and the sub-culture on the special medium showed microscopic evidence of growth in ten days. Both the first and second sub-cultures showed growth visible to the naked eye after four weeks, which gradually increased, and reached a maximum in about eight weeks.

These tubes were easily sub-cultured on to fresh tubes of the same medium, but on none of the ordinary laboratory media were we able to get any evidenee of growth.

The third case of pseudo-tuberculous enteritis was obtained from Mr. Hamilton. Specimens of intestine, but no glands, were received on September 23, 1910. They showed the typical lesions of the disease, and a very large number of Jöhne's bacilli were present in the tissues. When delivered, the specimens had already commenced to decompose, but from them cultures were made as previously described, both directly and indirectly after treatment with ericolin solution, on various media, including some tubes of the tubercle bacillus medium. The tubes were capped with gutta-percha tissue and placed in an incubator at 39° to 40° C. The results were the same as in Case No. 2.

Cultures and subcultures were also obtained from a fourth case sent in by Mr. de Vine, and from a fifth case sent in by Mr. Hamilton.

Four strains of Jöhne's bacillus having been isolated on media containing dead tubercle bacilli, we next proceeded to test them on slightly modified media. We found that growth was not nearly so good in the absence of glycerine, but the exact percentage most

suitable for the growth of Jöhne's bacillus has not yet been determined, although we have reason to believe that about 4 per cent. by volume gives the best results. A higher per cent. sodium chloride solution can be used in preparing the medium, without any detrimental effect.

We found also that it was better to dry the growth of the tubercle bacillus after killing it and before making it up into medium, a fact which may be due to the formation of cracks or breaks in the continuity of the covering, enabling the essential substance to diffuse more easily into the medium. Experiments showed that ½ to 1 per cent. of the dried tubercle bacillus was the most suitable quantity to add. To obtain the best results, the dried bacilli should be ground up with the glycerine which has been mixed with an equal quantity of 0·8 per cent. saline and the remainder of the saline added later. The emulsion so obtained should then be steamed for fifteen minutes, and, when cool, added to the egg. The probable explanation for this is that the glycerine acts as a solvent for the essential substance, and some experiments to be described later tend to confirm this suggestion. We also tried some media similar to the above, in which the normal alkalinity of the egg was wholly or partially neutralized by hydrochloric acid; these were found to be unsuitable. This proves the necessity of maintaining a distinctly alkaline reaction.

In another series of experiments the egg was replaced by various other substances, such as broth or agar. These, as a rule, did not give such good results, although ordinary glycerine peptone bouillon, made distinctly alkaline, and containing ½ to 1 per cent. of dried tubercle bacilli, gave a fairly satisfactory growth. This, with other experiments to be described later, proved that Jöhne's bacillus can grow quite well in the absence of albumen.

We next proceeded to test our strains of Jöhne's bacilli on media in which the dead tubercle bacillus was replaced by various other micro-organisms. We soon found that some strains of human tubercle bacilli were more suitable than others; and, further, that if the human tubercle bacillus was replaced by the bovine type, no growth of Jöhne's bacillus took place, and that this was so even when sub-cultured from strains which had been growing outside the animal body for a year. Several strains of tubercle bacilli isolated from cats were also tested, but gave negative results.

The question then arose as to whether these results were due to the absence of some substance in the bovine tubercle bacillus, or to the presence of some toxic substance not found in the human type. This was tested by preparing four batches of medium, one containing ½ per cent. of dried human tubercle bacilli, another ½ per cent. of dried bovine bacilli, a third ½ per cent. of both the human and bovine types, and a fourth ¼ per cent. of both types. Several tubes of each were inoculated with pure cultures of Jöhne's bacillus and incubated at 39° to 40° C., with the following results: Growth took place on the medium containing the human type, and on the two containing both types, but no growth took place on that containing only the bovine type. This experiment proves fairly conclusively that the unsuitability of the bovine type of bacillus is not due to the presence of any toxic body in its substance, otherwise no growth would have

taken place on the media containing the mixture of the two bacilli. We may note, however, that we have not tested many strains of the bovine bacillus, and it is possible that Jöhne's bacillus will grow on some bovine strains, or on those strains which have been described as occupying an intermediate position between the typical human and typical bovine bacilli; but we have no evidence that this is so.

While in this paper we cannot enter into the controversy concerning the relationship between the human and bovine types of tubercle bacilli, yet, incidentally, we venture to remark that, in spite of all that has been written in this country, we are not yet convinced that the human and bovine types are only slightly different varieties of one and the same micro-organism. In this connection the difference between the two bacilli described above may be worthy of note and further investigation.

The failure to obtain any growth of Jöhne's bacillus on media containing tubercle bacilli isolated from bovines and cats led us to seek for other acid-fast bacilli which might act as substitutes for the tubercle bacillus of man, and two bacilli at once suggested themselves. As we have already remarked, O. Bang has shown that avian tuberculin may cause some reaction with pseudo-tuberculous enteritis of bovines, and the possibility of the avian tubercle bacillus and Jöhne's bacillus being closely allied is at once obvious.

Accordingly we prepared several batches of medium containing the avian tubercle bacillus in place of the human type. On this medium our strains of Jöhne's bacillus usually grew, but only slightly, and the medium proved to be quite unsuitable for practical purposes.

The other micro-organism which suggested itself was the timothy-grass bacillus. This was substituted for the human tubercle bacillus and similar cultures made. These culture grew quickly and well, the growth being better than on any of the media containing the human tubercle bacillus. A slight growth was visible along the needle track after incubation for one week, and after six weeks the growth closely resembled that of a bovine tubercle bacillus recently isolated from the animal body. A full description of the cultural characters of the bacillus will be given later. The smegma bacillus of Moeller, the nasenschleim bacillus of Karlinski, and the fish tubercle bacillus of Dubard were then tested in place of the human tubercle bacillus; each type was added to the medium in quantities of ½ to 1 per cent. of the dried powdered growth. The first two media gave satisfactory results, but were not quite so good as media containing the timothy-grass bacillus. The fish tubercle bacillus medium gave negative results, but so far only one batch of this has been tested. The butter bacillus of Rabinowitsch was also found to be unsuitable. Certain blastomyces and non-acid-fast bacilli which have been recently investigated also gave negative results.*

Having determined the various acid-fast bacilli most suitable for

* Subsequent experiments have shown that the following acid-fast bacilli can also be used in the medium, and give good results: *B. pseudoperlsucht*, Moeller; *B. aus Harn*, Marpmann; *B. aus Butter*, Grassberger. No positive results have yet been obtained with the Tobler group of acid-fast bacilli (January 29, 1912).

the growth of Jöhne's bacillus, an attempt was made to extract the essential substance from certain of these bacilli. The timothy-grass bacillus was chosen, chiefly because it gave the best results in the above experiments, also because it is harmless to man and grows quickly on simple media, thus enabling a large quantity of growth to be obtained in a short time.

From the results of the experiments we judge that the essential substance is only very slightly, if at all, extracted by distilled water, but that it is soluble in a glycerine saline solution, although from the above it is clear that some of the essential substance remained in the residue.

Other experiments prove that the substance in the timothy-grass bacillus essential for the growth of Jöhne's bacillus is extracted by hot ethyl alcohol.

In considering pseudo-tuberculous enteritis from an hygienic standpoint some important factors have to be considered. The disease is widely distributed, and is easily conveyed from one animal to another, probably by means of contaminated food, such as grass. In the early stages the symptoms are slight and indefinite, and an early diagnosis is impossible. The affected animals lose considerable weight, and with milch cows the quantity of milk given is greatly diminished. In view of these facts it is clear that a reliable diagnostic vaccine would be of great economic value, and if generally used in the infected areas of the countries in which the disease is prevalent, and if followed by the slaughter of the diseased animals, would soon tend to diminish if not to completely eradicate this condition.

It must also be remembered that when animals suffering from this disease are slaughtered, the flesh is not condemned as food unless the carcase shows marked emaciation, so that an early diagnosis would not only help to prevent dissemination of the disease, but would allow of a better price being obtained for the animal.

From this it follows that the use of such a vaccine would be of direct monetary value to farmers and stock owners, and if State legislation were adopted no Government compensation would be necessary.

From the strains of Jöhne's bacillus which had been grown, attempts were made to prepare a vaccine which would be both efficient and specific as a diagnostic agent for the disease under discussion. The experiments, unfortunately, had negative results. Details of the experiments are given in the original paper.

The specific bacillus of pseudo-tuberculous enteritis, commonly known as Jöhne's bacillus, is, as already stated, allied to the various tubercle bacilli, and therefore belongs to the same general group. If we accept the classification of micro-organisms adopted by Léhmann and Neuman, it would be more correct to describe it as a mycobacterium, and the scientific name of the micro-organism would then be *Mycobacterium enterilidis chronicæ pseudotuberculosæ bovis* Jöhne, the name by which we suggest it should be known. At the same time, throughout this paper we have thought it better to retain the common name of Jöhne's bacillus. We were unable to detect any difference in the five strains isolated, and the culture

recovered from the experimental bovine No. 5 also agreed in every detail with the other bacilli. In the diseased lesions the bacilli often appear in extremely large numbers. They are present as slender rods, sometimes slightly bent, and are usually between 1 and 2 microns in length. They often show a beaded appearance, but this is not so marked as with the tubercle bacillus. When first cultivated from the animal body on the special media described in this paper, the bacilli grow longer and thicker, and lie side by side in a manner very similar to the tubercle bacillus. If the medium is partially dried they may grow to a length of 5 microns or more, and show definite dichotomous branching, with club formation and very distinct beading. When subcultured on to moist solid medium, the bacilli soon regain their slender and short form, and in vigorous growing cultures they may become very short and show but little beading. The bacilli at this stage often lie side by side, but loosely and not in the typical manner of the early cultures. Spore formation was not observed in any of our growths. In none of the strains have we been able to detect any evidence of motility.

Like the tubercle bacillus, Jöhne's bacillus, if obtained from diseased tissues or from a pure culture, stains imperfectly and with difficulty with aqueous solutions of the anilin dyes, but quite well with Gram's method, and better still with Ziehl-Nielsen's. It is quite acid-fast, and retains the stain when treated with 25 per cent. sulphuric acid or 1 per cent. hydrochloric acid in spirit.

No growth was observed in the absence of oxygen or with considerable excess of oxygen. If sub-cultures which have been kept anaerobically for three months at 39° C. are placed under aerobic conditions, the cultures grow, showing that although the bacillus does not grow anaerobically it is not killed by the absence of oxygen.

Growth occurs between 28° C. and 43° C., or perhaps a little beyond these limits, the optimum being about 39° C., but it is always slow. The reaction of the medium should be distinctly alkaline ; the degree of alkalinity possessed by new-laid eggs is very suitable, and if this is in any way lessened in the medium there is a marked diminution in the rapidity and amount of the growth. As has been stated, no growth occurs on any of the artificial media in general bacteriological use, such as peptone bouillon, agar, gelatine, serum, potato, or egg, even when such substances as glycerine, sugars, amino-acids, fresh blood, &c., are added. It is absolutely essential that certain previously detailed bacteria or extracts from them be added to one or other of the media, before any growth of Jöhne's bacillus takes place, and this is equally true for strains of Jöhne's bacillus which have been freshly isolated from the animal body and for strains which have been cultivated on artificial media for fifteen months or more.

Of the bacilli tested, undoubtedly the most suitable for adding to the medium is the timothy-grass bacillus ; certain strains of human tubercle bacilli are also very good.

On the egg timothy-grass bacillus medium previously described, Jöhne's bacillus, when taken from the animal body, will grow as tiny discrete colonies which usually become visible in three to five weeks. At first the colonies are round, smooth, and dull stone white, they

are slightly heaped up, and as growth increases this becomes more marked, while the colour turns to a dull light yellow. Later, the colonies may coalesce and the growth show some wrinkling, while the colour may change to a light yellowish brown. The degree of pigmentation seems to be considerably influenced by the amount of pigment in the timothy-grass bacillus incorporated in the medium, and possibly also, though to a less extent, by the colour of the egg itself.

If the first culture taken from the diseased tissue is sub-cultured on to a fresh tube of medium, visible growth occurs on this in a few days, and may reach its maximum in about two months instead of three. The growth now appears as a heaped-up continuous line along the needle track, with only an occasional discrete colony at the margins. Wrinkling of the surface may also be more marked, especially if the culture is growing very well on a tube which is a little dry. When the timothy-grass bacillus in the medium is replaced by any of the other suitable bacilli or bacillary extracts, the growth of Jöhne's bacillus does not materially differ from the description given, except in rapidity and amount, and also in the degree of pigmentation. When inoculated into fluid media containing a suitable bacillus or bacillary extract, such as ordinary glycerine peptone bouillon, made alkaline, and containing ½ per cent. of alcoholic extract of timothy-grass bacillus, Jöhne's bacillus grows as tiny whitish grains which settle to the bottom of the tube or flask. These gradually increase in size and number, ultimately reaching the dimensions of a millet seed. There is no general turbidity of the medium ; and with bacilli freshly isolated from the animal body, no film formation. With one of our strains we have recently obtained some growth on the surface of the fluid media, and we expect, in course of time, to obtain a similar growth with the other strains.

Vaccines analogous to Koch's new tuberculin and Wright's vaccines can also be prepared, but so far we have not had an opportunity of testing the curative effect of these, and, even if successful, the cost of administering such vaccines would prevent their general use. So far, we have been unable to prepare a diagnostic vaccine of sufficient strength to give a positive result with pseudo-tuberculous enteritis, but we anticipate that it will be possible to prepare such a vaccine with the bacillus growing more vigorously on the surface of fluid media.

Cultures are not easily killed by diffuse daylight, as we have had them standing before a window on the bench for some weeks without any apparent harm.

Jöhne's bacillus would also appear to be fairly resistant to the action of disinfectants, since two of our strains were isolated from material which had been subjected to the action of a 1 per cent. watery solution of ericolin at 37° C. for two hours. In this respect it is no less resistant than the tubercle and lepra bacilli.

Conclusions.

From the experiments detailed in this paper it is possible to deduce certain conclusions, the most important of which are the following :—

(1) The acid-fast bacillus present in cases of pseudo-tuberculous enteritis of bovines, and known as Jöhne's bacillus, fails to grow outside the animal body on any of the artificial media at present used by bacteriologists.

(2) The bacillus shows no definite growth on fresh bovine tissue or fresh extracts of bovine tissue removed aseptically and placed into sterile tubes.

(3) There is no evidence that Jöhne's bacillus grows in symbiosis with an ultra-microscopic virus.

(4) The specific bacillus will grow on media containing the dried and powdered growth of certain acid-fast bacilli which have been previously killed, and this is so even when the dead bacilli have been kept for a period of eight years, and subjected to a temperature of 115° C. in the autoclave for one hour.

(5) The most suitable bacillus to incorporate in the medium is the timothy-grass bacillus, and to a somewhat less degree the smegma bacillus of Moeller and the nasenschleim bacillus of Karlinski. The human type of tubercle bacillus is also good, but on media containing the avian type Jöhne's bacillus grows very slightly, if at all. With the few bovine strains tested in media we were unable to get any definite evidence of growth with Jöhne's bacillus. Tubercle bacilli isolated from cats also gave negative results.

(6) The essential substance or substances necessary for the growth of Jöhne's bacillus can be extracted from the various acid-fast bacilli which give positive results by means of hot ethyl alcohol.

(7) We have isolated Jöhne's bacillus from five consecutive cases of pseudo-tuberculous enteritis, and have proved the morphological and biological characters of the bacilli isolated to be identical in every respect.

(8) The bacilli isolated produce no lesions in mice, rats, guinea-pigs, rabbits, pigeons, or hens, if given by the mouth or inoculated into the peritoneal cavity or into a vein or subcutaneously.

(9) The specific bacillus, when inoculated intravenously or given by the mouth to bovines, reproduces pseudo-tuberculous enteritis in the animal, and this cannot be distinguished from the original disease either clinically during life or *post mortem*. Further, the bacillus can be recovered from the lesions in the intestine of the inoculated animal, and shows characters in every way identical with the bacilli isolated from the original cases.

(10) Animals suffering from pseudo-tuberculous enteritis, either normally contracted or experimentally produced by the inoculation of pure cultures of Jöhne's bacillus, give no definite reaction with diagnostic vaccines prepared from cultures of the timothy-grass bacillus or from the avian tubercle bacillus.

(11) Vaccines can be prepared from cultures of Jöhne's bacillus similar to those prepared from other acid-fast bacilli.

(12) Diagnostic vaccines prepared from cultures of Johne's bacillus grown on tubercle bacillus medium gave positive reactions with tubercular animals, which proved the medium used to be unsuitable for the preparation of a specific diagnostic vaccine for pseudo-tuberculous enteritis.

(13) Vaccines prepared from cultures of Jöhne's bacillus on a

timothy-grass bacillus medium gave negative reactions with normal and with tubercular animals, and also with bovines suffering from pseudo-tubercular enteritis. We believe this to be due, partly to the small amount of growth in the fluid media, and partly to the fact that most of the growth was obtained from solid media and therefore not made in the same manner as diagnostic tuberculin. We also believe that a highly concentrated vaccine will be required, and that we shall be able to prepare this now that one of our strains of Jöhne's bacillus has started to grow on the surface of fluid media containing the timothy-grass bacillus.

In conclusion we may say that we are greatly indebted to Mr. de Vine, Mr. Hamilton, and Dr. Bulloch for the specimens and materials they have given us, to the donor of a naturally infected bull, and especially to the Royal Society for the Government grants which enabled us to purchase the other animals. An investigation such as this requires a large number of bovine experiments, but these we have been unable to perform through lack of funds. Insufficient apparatus in the earlier stages also caused us considerable delay in the preparation of an efficient diagnostic vaccine, and we had no animals on which to test the first vaccine prepared. We now possess the necessary apparatus, and a number of vaccines are in course of preparation, but unless the animals on which to test the vaccines are forthcoming, we shall be unable to prove the efficiency or otherwise of the vaccines and shall be forced to leave it to other workers more favourably placed financially. In any case it is to be hoped that other workers will test a diagnostic vaccine prepared in the manner we have indicated, for the economic loss from pseudo-tuberculous enteritis in such places as Denmark and the Channel Islands is of a very serious nature.

Some months ago we sent sub-cultures of the specific bacillus which we had grown to various workers in the British Isles, France, and in Denmark, and we hope that the desired vaccine will soon be obtained.

Reviews.

"The Morphology of the Vermiform Appendix." By Walter Stapley, M.D., D.V.Sc., M.R.C.V.S., and J. C. Lewis, B.V.Sc., Melbourne University Veterinary School.

In a paper read before the Royal Society of Victoria, Messrs. Stapley and Lewis discuss the morphology of the vermiform appendix of different animals, comparing them with that of man.

The animals especially dealt with are the wombat, rabbit, kitten, baboon, lemur, Tasmanian devil, koala, and Flinders Island wombat (*Phascolomys ursinus*).

Their endeavour is to show that the evidence of comparative anatomy is directly opposed to the theory that the appendix is what might be termed an "abdominal tonsil," and in confirmation

of their contention they point to the fact that the cæcum of the cat has no vermiform appendix, but contains practically as much lymphoid tissue as does the cæcum of man.

The paper covers an enormous amount of original work and thought, and is of great interest to the student of the comparative aspect of the appearance and functions of this portion of the intestines.

"Bovine Tuberculosis—Cause, Cure, and Eradication." Pp. xviii and 459, with 80 illustrations. First Edition. Published by J. Bibby and Sons, Liverpool. Price 10s. net.

This extremely useful work, which forms Section IV of "Bibby's Book on Milk," is described on its title-page as "a summation of material facts and eminent opinions for the use of farmers, cattle-owners, milk-producers, veterinarians, students and others." This description gives one an idea of what to expect, and we say at once that it is the best and fullest compilation of facts and opinions relating to bovine tuberculosis that it has been our good fortune to meet with. In fact, almost all authorities who have worked on the subject and published their results are quoted whatever their views may be, so that the case concerning tuberculosis is stated with impartiality, giving the views of the medical officers on the one hand and those of the farmers and milk-producers on the other, together with the results of the research workers and the veterinary surgeons' aspect of the question.

Chapter I deals with the causation and importance of bovine tuberculosis; Chapter II with the relationship of human and bovine tuberculosis. Chapter III is devoted to the symptoms of tuberculosis in cattle, with special reference to the udder and methods of contamination of the milk, and the infectivity of milk and meat and dairy products. Chapter IV considers the extent of the danger of bovine tuberculosis to man, and Chapter V discusses the cattle-owner's standpoint. Chapters VI and VII deal with the suppression of the disease and the plan of campaign. Chapter VIII is no less important than the rest, and details various researches in progress, and some of the conclusions arrived at concerning vaccination, serum diagnosis, &c.

There are several appendices, including a very short one on bovine actinomycosis, concerning which on p. 410 a curious misstatement is made, viz., "Extreme emaciation may result in actinomycosis . . . ." Needless to say no degree of emaciation can cause actinomycosis, and no doubt the converse is what is intended. Two excellent appendices refer to Jöhne's disease and calf mortality, but unfortunately no reference in the former is made to Twort and Ingram's work. This work concludes with an article on destruction of rats, a paragraph on avian tuberculosis, and a glossary which the layman will find very useful.

The book is well illustrated, and the plates—eleven of them being coloured—and figures excellently reproduced; but we do

not know why so many portraits are introduced, while one figure, illustrating the taking of a cow's temperature on p. 216, is neither interesting nor edifying, and would be better omitted.

We welcome the book heartily, and shall await the other sections of the work with interest. G. H. W.

Swamp Fever in Horses. By L. Van Es, M.D.V.S.; E. D. Harris, D.V.M.; and A. F. Schalk, D.V.M.

The above is the title of Bulletin 94 originating from the Department of Veterinary Science of the North Dakota Agricultural College. The results of a systematic investigation of the disease are recorded in the 345 pages of which the pamphlet consists. The peculiar disease known as swamp fever has occasioned considerable damage in the North-West Territory. It has been known in Manitoba since the year 1881, and in the year 1889 was also recognized in the State of Wisconsin.

The authors consider that fever is perhaps the most constant symptom of the disease. The range of temperature lying between 101° F. and 104° F. In experimental cases it is the first symptom, and about the only one sufficiently pronounced to have a diagnostic meaning. The pulse-rate is often influenced by the temperature, but towards the end it becomes smaller, weaker, and at last imperceptible. Its rate may be 55 to 65 beats a minute, and before death it may go up to 90—100.

The disease may be described as "a specific septicæmia of the horse species (transfusion experiments to other animals failed) due to the presence and vital activity of virus, which thus far has been demonstrated only in an ultramicroscopic form and characterized by a more or less intermittent fever and albuminuria accompanied by a progressive anæmia."

Animals showing symptoms of swamp fever should not be removed from place to place. Recently purchased horses should only be introduced carefully among healthy stock. Owners of non-infected stables within the sections where disease is prevalent should make their purchases outside the infected district.

The blood and urine of infected animals transmit the disease, hence thorough stable disinfection must be rigidly carried out with housed horses, and animals out in the field should not be pastured on damp, swampy, or marshy land. Here probably most infections occur through contamination of the foliage and waterpools by the urine of swamp fever cases and "infection carriers." Horses should be prevented from using water found in ditches or pools, and water-supply should be derived from wells protected from surface drainage. Wells sunk immediately under the stable, as on many farms in the North-West, constitute a real source of danger.

Biting insects may play a part in the spread of the disease. The results of the investigations at the Experiment Station may be summarized as follows:—

(1) Swamp fever is a disease of infection, transmissible by

subcutaneous and intravenous injection and by ingestion through the alimentary canal.

(2) The virus producing the disease is contained in the blood and urine of affected animals, but it is absent from the fæces.

(3) The virus has thus far been demonstrated only in an ultramicroscopic form.

(4) The virus is resistant to the severe freezing weather of our more northern climates.

(5) Whilst not denying the possible transmission of the disease to healthy animals by means of insects and parasites, animals contract the disease naturally by the ingestion of food and water, contaminated by the urine of an infected horse.

(6) The disease is essentially a septicæmia marked by subserous and subendocardial hæmorrhages, degenerative changes in heart, liver and kidneys, and alterations in the bone marrow of the long bones of the limbs.

(7) The chief and most constant manifestations of the disease are fever and albuminuria.

(8) Many cases of swamp fever terminate fatally without a marked reduction in the red blood-cells, a fact denying the popular conception of swamp fever being primarily an anæmia.

(9) The blood of an anima! may remain virulent for as long as thirty-five months without the infected horse manifesting any clinical evidence of the fact.

(10) Such non-clinical infection carriers probably play an important part in the establishment of more or less permanent centres of infection.

(11) Both trypanblue and atoxyl are worthless in the treatment of the disease.

(12) Destruction of diseased animals, segregation of suspects, care in introducing new horses into the stable, the safeguarding of food and water-supply from urine contamination, pasture drainage, and stable disinfection, are the best prophylactic measures. G. M.

Translations.

A COMPLETE BILATERAL LUXATION OF THE PATELLÆ.

By Chief Veterinary-Surgeon BLUMENTRITT.

"Othero," a young restive remount horse, had been very ill with colic. It was caused by paralysis of the colon, and lasted ten days. After subsidence of the colic general weakness of the subject remained. One evening the horse stood stiffly with both thighs projected outwards and forwards, he could not move from his position, and both patellæ were luxated outwards and upwards. The left patella was immediately put back to its normal position by lifting and carrying the leg forwards, and it continued to remain in place. The right patella was first put in position on

the fourth day when the animal was recumbent. On standing up it was again luxated, and after carrying the leg forward, and inward pressure, it was put back into normal position, from which it now and then became luxated. By the help of straw bales a quite narrow stall was now constructed, in which the horse could not move sideways, and now the patella continued to remain in its normal position. Both patellar regions of the thighs were rubbed with camphor liniment. After ten days standing in this narrow stall no more lameness was present, the patellæ remained in their right place, the horse was cured.

As a cause of this luxation striking out behind of very irritable horses with a flabby constitution no doubt has its effect.—*Zeitschrift für Veterinärkunde.*

AN IDEAL ABATTOIR.

By T. S. C.

A REPORT of investigations and recommendations concerning the reconstruction of the great La Villette abattoir in Paris is not without some interest to us, and may be of practical guidance to English municipalities under similar exigencies.

As frozen or even chilled meat is very little used by the French in general, and as there is little likelihood of the Parisians in particular ever being persuaded to consume any meat that is note home-killed, it is necessary, in view of the growth of population and of consequent requirements, to make provision for the increasing future consumption of meat as well as for immediate needs. Not that it is proposed to build now in excess of requirements, but it is considered wise to acquire land surrounding the abattoir in order that further enlargements may be possible as time goes on.

Great importance is placed by our French neighbours on scientific organization in slaughter-houses. We may learn something in this respect. The following are the principal points to be considered:—

(1) It is considered essential that there should not be any private butchering; therefore public slaughter-houses are to be provided and furnished with the necessary mechanical devices for the proper carrying out of all the work that has to be done. Though these slaughter-halls are to be used in common, private scalding-tanks and market-places will continue to be available.

(2) Sections for the slaughter of cattle will be kept separate from those for the slaughter of smaller beasts.

(3) A practical and effective system of disembowelling and subsequent treatment of paunches and intestines will be adopted.

(4) Pork will always be scalded, as this method of dealing with it is found to be cleaner and preferable in every way to singeing the carcases.

(5) No materials that are liable to putrefaction will be used in any detail of construction. Iron will be used for barriers, pens, and paddocks for waiting and counting. The ground

everywhere will be rendered absolutely impervious to moisture, and slaughter-places will be lined with tiles.

(6) The organization of refrigerators will be an important feature. Obviously it would be inconvenient to have them grouped all together, and it would be burdensome to place them about in different parts of the abattoir. To reconcile convenience with economy, the best arrangement would be to centralize the refrigerators towards the middle of the abattoir, so that one should be at the end of each slaughter-place, which would radiate outwards from the centre, like the spokes of a wheel, to the waiting-places. These would form the extreme circumference of the supposed wheel. The ring of refrigerators would be as the outer rim of the axle-box, while the machinery would occupy the inner circle of the axle.—*From La Vie Agricole.*

EPILEPSY WITH SUBSEQUENT AMAUROSIS IN A HORSE.

By Staff Veterinary-Surgeon WILCZEK.

A very well-bred saddle-horse of East Prussian breed and of irritable temperament had for years to be prepared for shoeing with a morphia injection. The last time of being shod morphine did not seem to produce sufficient effect, and I tried other means. Since chloral hydrate could neither be used after long periods of thirst and severe work, nor yet as a clyster, I tried shoeing with the aid of Hauptner's lasso, the usefulness of which on an obstinate horse I had previously tested.

After much trouble the apparatus was finally adjusted. Each attempt to shoe the horse or get near it was hindered by fighting and throwing itself down. With every stroke of the hammer the excitement increased; the horse trembled, sweated, panted, and drew itself together with a squealing cry. With its back arched, head and neck between its limbs, the horse then lay without any sign of consciousness. Reflexes never occurred; the membrana nictitans was greatly protruded; the pupils were distended to the utmost. Muscular spasms commenced in the masseters and quickly travelled tailwards; the limbs were tetanically stretched out. The heart-beats were thumping, the pulse thready, scarcely perceptible, and much quickened (90 to 100).

The spasm lasted almost thirty minutes, the muscles were gradually relaxed, the extremities first became movable, and consciousness returned. Efforts to raise the horse with supports were a failure, and I already feared a spinal lesion.

After about an hour, however, the animal sprang up very briskly, and stepping very high and with uplifted head went straight into a wall. Examination of the eyes was completely negative.

The pupils reacted promptly to every change of light; neither the dioptric apparatus nor the interior of the eye showed the slightest pathological changes; however, the horse was quite blind; he was amaurotic and glass-eyed. The whole condition of the patient pointed to hæmorrhage on the brain. He was very

timid, held his head supported on the manger, had a temperature of 39.3° C., seemed at times, according to the attendant, as if "crazy," only drank water from the manger, and not as heretofore from the bucket. Gradually his condition became normal again, the sight of the right eye returned after ten days, but the left remained blind with ptosis, and retracted more and more into the socket. Examination with the ophthalmoscope later on showed plain anæmia in the connective tissue vessels and slight atrophy of the iris of the left eye. It was remarkable that for a long time the pupil reacted to the influence of light.

A second epileptic attack did not follow the first; the horse was not shod again, and later on was sold.—*Zeitschrift für Veterinärkunde.*

ON THE TREATMENT OF INFECTED WOUNDS, PHLEGMONY, PANARITIUM, AND ADENITIS WITH GLYCERINE DRESSINGS.

By RUSCA.

GLYCERINE was often used for wound treatment in the pre-antiseptic period, and was very strongly recommended by Demarquay, 1854; Lister's discovery caused it to be quite overlooked and forgotten. The author has obtained favourable results with glycerine dressings in about 100 cases of infected wounds, phlegmonies, &c., and has seen neither local nor general objectionable results from their use even when applying them for a month at a time in large wounds. The technique is quite simple; a compress soaked in glycerine is applied directly to the affected spot, and covered with impermeable and air-tight material. The dressing is changed twice daily. Wounds infected with pus organisms are very favourably influenced by glycerine, inflammatory symptoms rapidly decline as well as secretion. The wound is quickly cleansed, and healthy granulations soon occur. The more acute the appearances the better the effect of glycerine dressings.—*Der Tierärzt.*

CONTRIBUTION TO THE STUDY OF ALOPECIA IN A HORSE.

By FAYET AND TORTIGNE.
(*Revue Vétérinaire*).

THE question of alopecia always remains very obscure, and the most varied causes have been invoked for it; infectious diseases, parasitic, bacterial, intoxication affections, reflex irritations, emotions, cold, &c.

The veterinary surgeons to the 19th Hussars report three very interesting cases which add useful information to the matter.

(1) *Frisette*, half blood, was fired over the tendons, was very nervous, and fought violently; three days after numerous pellicles caused scaling over the body, particularly on the thorax; on the morrow the hair began to fall out, ten days after the skin was completely bald over a part of the thorax. No itching, no parasites, good appetite, neither general disturbance nor pathological antecedents.

(2) *Fidelis*, a blood mare, was fired in the same conditions ; some days after the same phenomenon declared itself on the superior parts of the body.

These two cases appear attributable either to ischæmia from cold (Deysine), or cutaneous congestion (Fünfstuck) or fright.

(3) *Gamine*, half blood, was exhibited to us on January 2 for patchy depilations as large as the hand at different parts of the body and for oozing at the articulations. The hair and the mane could be easily pulled out in tufts ; slight itching disappeared after clipping and washing with soap, but all the hair was carried away at the same time ; œdema of the chest and under the belly disappeared some days after. On January 5 the mare was completely bald except on the extremities. No parasites, no general symptoms, good appetite ; the record showed an attack of pasteurellosis from May 19 to June 11 of the preceding year.

One cannot incriminate an irritating washing by reason of the generalization and regularity of the alopecia. Examination of the dung showed corpuscles analogous to coccidiæ, but attempts to cultivate them were not followed by evolution ; however, a study of the blood revealed very pronounced eosinophilia (6.83).

Examination of the hair was negative, although trichophyton was rife in the regiment.

This mysterious alopecia was not of long duration, the hair grew again rapidly.—*Revue Gén. de Méd. Vét.*

Letters and Communications, &c.

Mr. Maxwell Edgar; Dr. Frank Attwood; Mr. Eaglesham; Mr. A. E. Willett; Mr. Guy Sutton; Mr. Watson; Mr. T. Goodall; Mr. T. B. Goodall; Mr. G. Mayall; Mr. J. Willett; Mr. G. Heslop; Dr. Stapley; Mr. H. C. Ganguly; Mr. S. Mitter; Mr. H. Taylor.

Books and Periodicals, &c., Received.

Journal of the Royal Army Medical Corps; Recueil de Médecine Vétérinaire; L'Hygiène de la Viande et du Lait; Revue Générale de Médecine Vétérinaire ; Der Tierarzt ; Zeitschrift für Veterinärkunde ; Berliner tierärztliche Wochenschrift ; Osterreichische Wochenschrift für Tierheilkunde ; La Clinica Veterinaria ; Revista de Medicina Veterinaria ; Board of Agriculture and Fisheries ; Department of Agriculture and Technical Instruction for Ireland ; Kennel Gazette ; Agricultural Journals for the Union of South Africa and for Rhodesia.

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